

# THE ILLINOIS RIVER

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## PHYSICAL RELATIONS

AND THE

## REMOVAL OF THE NAVIGATION DAMS

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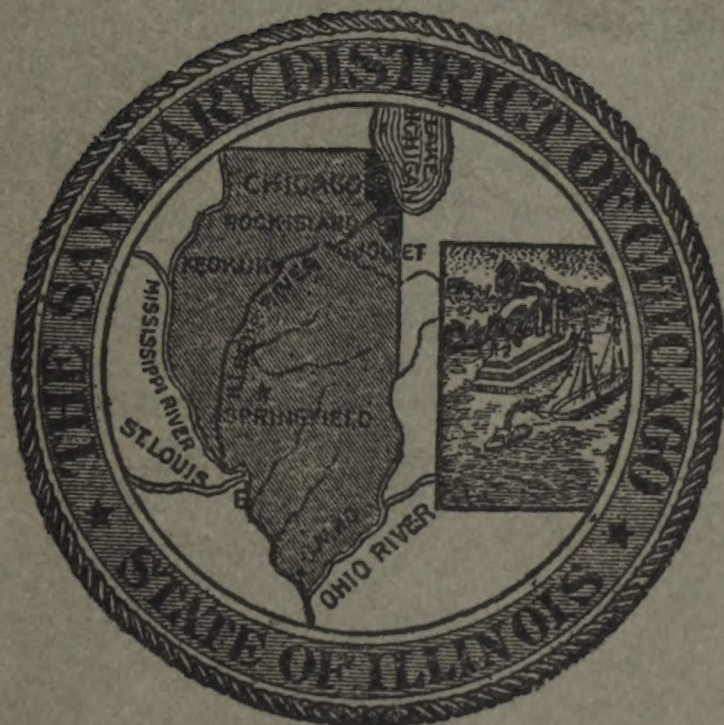
WITH SUPPLEMENT

ON THE

Waterway Relations of the Sanitary and  
Ship Canal of Chicago

BY

LYMAN E. COOLEY



AUGUST, 1914









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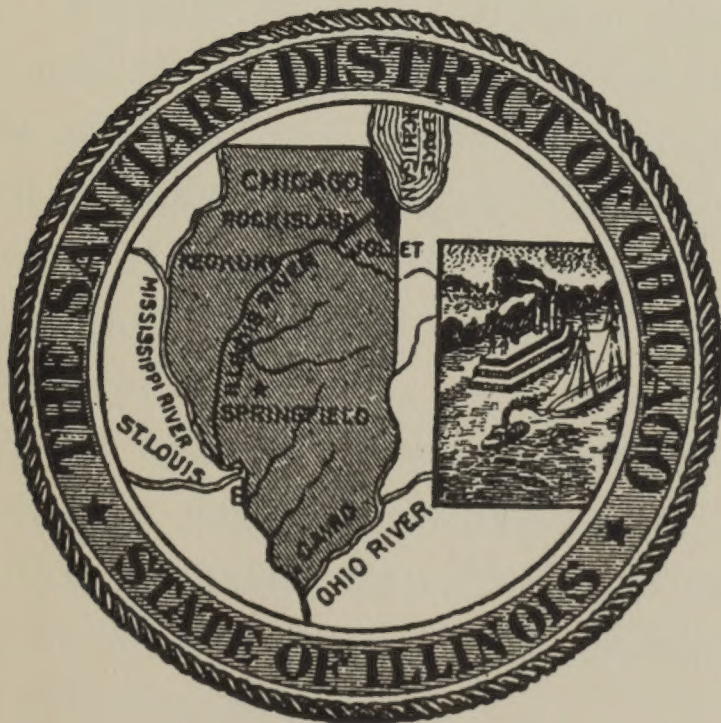
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PHYSICAL RELATIONS

STUDY OF THE NAVIGATION DANGERS

THE ILLINOIS RIVER

CLOHESEY & CO.  
PRINTERS  
102 N. FIFTH AVENUE  
CHICAGO



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## **PREFACE.**

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This document was prepared by my instructions of August last in compliance with the suggestion of the Governor of this State, the Honorable Edward F. Dunne. A manuscript copy was sent by request to the Governor on May 19th, and thereby became a public document. The preparation and publication of the matter has been delayed by reason of the press of other duties on the office of Consulting Engineer.

The primary purpose is to set forth the pertinent facts relating to the removal of the navigation dams in the Lower Illinois River, and increasing the capacity of the stream-bed, between Utica and the Mississippi River. The general purpose is to develop the physical conditions in the Illinois Valley in relation to the sanitary problem of Chicago and the deep waterway. Something more than a year ago, the District issued the brief entitled "The Diversion of the Waters of the Great Lakes by way of the Sanitary and Ship Canal of Chicago," and this is a companion document dealing with these waters and their utilization in the passage through the Illinois Valley to the Mississippi River.

The District does not assume any responsibility for the opinions and conclusions herein expressed, but issues this document as a matter of public information and commends it to the consideration of all who may feel concern.

THOMAS A. SMYTH,  
*President.*

August 31, 1914.







## EXPLANATION.

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HON. THOMAS A. SMYTH, President:

In accordance with your instructions, I called upon the Governor, the Hon. Edward F. Dunne, at Springfield, in August last, in reference to the removal of the dams in the Lower Illinois River and the improvement of the stream. The Governor advised the preparation of a brief which should set forth the material facts and which he could refer to the Canal Commissioners pending a hearing. I was then directed by you to prepare such a document and I herewith submit the same.

I have endeavored to make the report so complete and comprehensive that the subject matter would be finally disposed of. Much time and patience has been required and other duties have intervened, all of which have occasioned delay. The questions involved are grave and invite early action.

In considering this report, if greater detail be desired, reference can be made to the following documents:

Further Testimony, Special Joint Committee,  
General Assembly of Illinois, April 7, 1887.

Lakes and Gulf Waterway, Citizens Association,  
Chicago, January, 1888.

Lakes and Gulf Waterway, as related to the Chicago Sanitary Problem, August, 1890. (Official S. D.) Published by subscription May, 1891.

The Lakes and Gulf Waterway, 1907. Report of the Internal Improvement Commission of Illinois.



“Reclamation”—Association of Drainage and  
Levee Districts of Illinois. Address at Peoria,  
July 18, 1911. Published by Association.

Hearing before U. S. Senate Committee on Com-  
merce, April 16, 1912.

Other documents which relate less particularly to  
the Lower Illinois are referred to in the text.

Respectfully submitted,

LYMAN E. COOLEY,  
*Consulting Engineer.*

Chicago, January, 1914.

Since the foregoing report was prepared, it has  
been deemed expedient to complete the document by  
adding thereto a study of the conditions below Hav-  
ana in relation to the Federal dams. Duties in con-  
nection with the Federal case and special investiga-  
tion have greatly delayed the preparation of the ad-  
ditional matter.

L. E. C.

April, 1914.



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## THE ILLINOIS RIVER.

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### A—General.

1. *The Illinois River Basin* comprehends, in round numbers, twenty-eight thousand (28,000) square miles, an area equal to half of the State of Illinois. It embraces the head of Lake Michigan, from which it is separated by a narrow margin, and extends southwesterly to the Mississippi River above St. Louis. The easterly arm is represented by the Kankakee Basin with an area of three thousand six hundred (3,600) square miles in the State of Indiana, and the northerly arm is represented by the Fox and Desplaines Basins with an area of one thousand and sixty-eight (1,068) square miles in the State of Wisconsin. The topography is gentle and rolling and substantially within a range of four hundred (400) feet in altitude.

The surface in nature is largely prairie with wooded stream lines and increasing woodland toward the north and with a large proportion of swamp and wet prairie. No other basin of equal area in the United States is richer in soil resources.

The water supply is so far consumed by the vegetal cover in the growing season, that little is left for the streams and this little has been diminished by drainage and reclamation, as observed in a Federal report as early as 1867-8.

2. *The Illinois Water Route* from Lake Michigan at Chicago by way of the Chicago Divide and



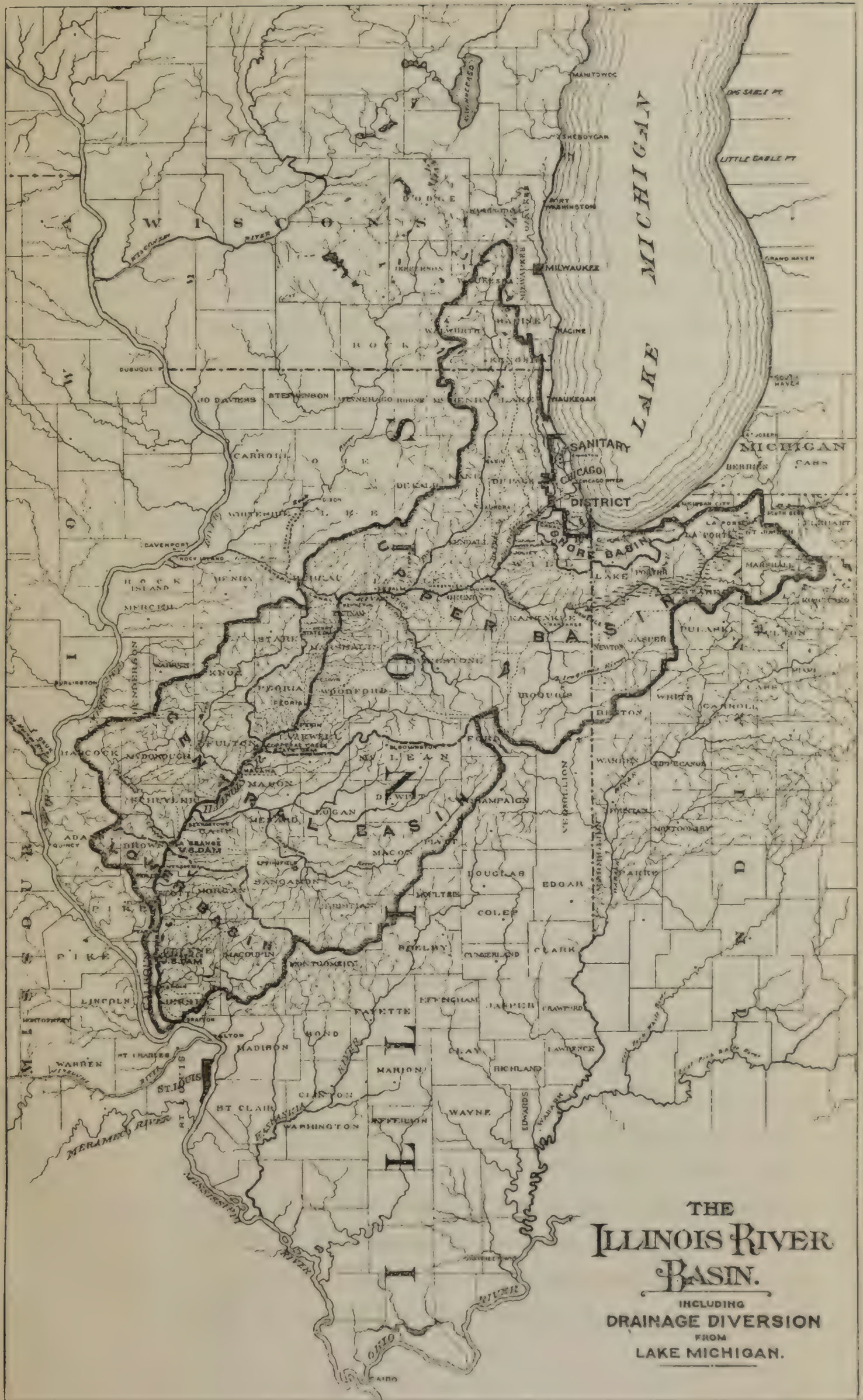
the Desplaines and Illinois River to the Mississippi River at Grafton, has a length of three hundred twenty-seven (327) miles. The Illinois River proper begins at the confluence of the Desplaines and Kankakee near the Will County line and fifty-four (54) miles from Lake Michigan.

*The Main Channel* of the Sanitary District, including the Chicago River, covers some thirty-nine (39) miles across the Chicago Divide to the Desplaines River at dam No. 1, Joliet, reaching a level of forty-two and four-tenths (42.4) feet below standard low water of Lake Michigan.

*The Upper Illinois*, including fifteen (15) miles of the Desplaines River below dam No. 1, covers the rock-bound valley from Joliet to Utica, a distance of fifty-eight (58) miles, with a declivity of one hundred four and six-tenths (104.6) feet to the natural low water level at Utica bridge, taken at one hundred forty-seven (147) feet below Lake Michigan prior to the construction of the Henry dam.

*The Lower Illinois* covers the alluvial valley two hundred and thirty (230) miles from Utica to the Mississippi River at Grafton, with a natural declivity of only twenty-eight (28) feet, or one and one-half ( $1\frac{1}{2}$ ) inches per mile. The Upper Illinois covers about eighteen per cent. (18%) of the total distance, from Lake Michigan to the Mississippi, with only eleven thousand eight hundred and twenty-nine (11,829) acres of land subject to overflow, while the Lower Illinois covers seventy per cent. (70%) of the total distance with three hundred forty-nine thousand two hundred and ninety-seven (349,297) acres under the flood of 1844 and outside of the fixed water areas.









*The Low Water Volume* is taken at six hundred and thirty-three (633) second-feet at La Salle in the earlier Federal reports, but subsequent low waters have been estimated as low as three hundred to four hundred (300 to 400) second-feet and these volumes are usually double below the Sangamon. Extreme low water of dry season occurs when lakes and marshes, particularly those of the Fox and Kankakee, are drained, but otherwise the low water volume is well sustained.

*The flood volume* has reached a measured volume of seventy-three thousand, seven hundred and thirty (73,730) second-feet at Morris; ninety-three thousand six hundred (93,600) second-feet at La Salle; and one hundred seventeen thousand (117,000) second-feet at Pearl near the mouth.

*The Profile* hereto attached shows the distances and elevations, the river bed and high water lines, between Lake Michigan and the Mississippi River at St. Louis.

**3.** *The Genesis of the Illinois Outlet* is the key to present physical conditions. The Tolleston beach, represented by the west ridge at Evanston and Rose Hill, corresponds to a lake level some thirty (30) feet higher and a flow twenty (20) or more feet in depth over the rock floor at Lemont, and a volume of water not greatly different from that of the present Niagara. The valley excavation was completed to Utica on the lower grade of a mighty volume, but the work was in progress above Utica with declivities and pools according to the resisting strata. The lake dropped to a level of sixteen (16) feet or more corresponding to the Evans-



ton beach, and again to a level of seven (7) or eight (8) feet, corresponding to the Englewood beach, in which the floor of the outlet was barely awash. The modern level was lowered about one foot in 1886-90 by the erosion of the head of the outlet at Port Huron.

*The Chicago Divide* on the rock floor above Lemont was less than eight (8) feet above the low water of 1847 (Chicago Datum) and three (3) feet above the high water of 1838. The Desplaines River found its way from Lyons to Lake Michigan across the floor of the old bay, but eventually deposited a barrier in the vicinity of Kedzie Avenue with a minimum elevation of ten (10) to eleven (11) feet above Chicago datum, which overflowed whenever the Desplaines River rose two to three feet above the old rock floor at Lemont. This divide continued unchanged down to 1854. The old Desplaines River bed survives in the South Branch of the Chicago River and in the depression and sloughs between Kedzie Avenue and the Desplaines River known as Mud Lake and to the early voyageurs as "Portage Lake," and "La petite Lac." These conditions determined Indian movement, the exploration of Joliet and Marquette in 1673, the "Illinois Route" of the fur trade up to the removal of the Indians in 1833-6 and the shifting of the northern boundary of Illinois when admitted as a state in 1818. The construction of the drainage canal, opened in 1900, and the completion of the river diversion in March, 1909, have permanently divorced the Desplaines River as a flood tributary to Lake Michigan.

MEAN SEA LEVEL.

630

579

530

480

430

380

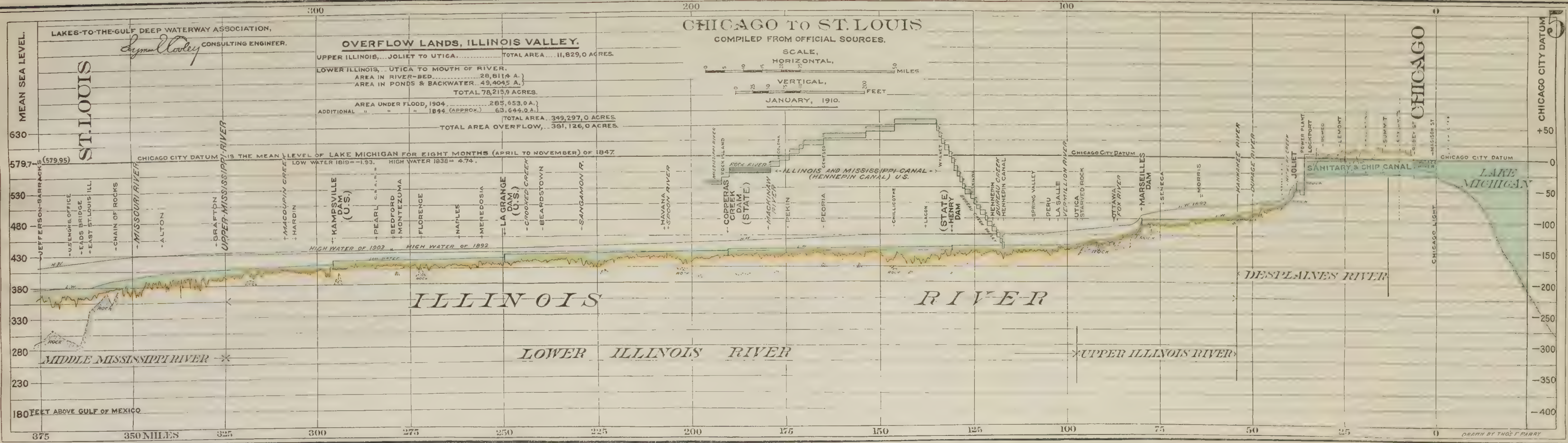
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280

230

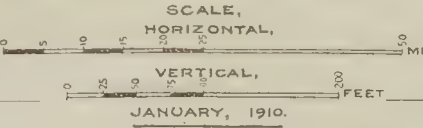
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# CHICAGO TO ST. LOUIS

COMPILED FROM OFFICIAL SOURCES.



**OVERFLOW LANDS, ILLINOIS VALLEY.**

UPPER ILLINOIS, JOLIET TO UTICA.....	TOTAL AREA.....	11,829,0 ACRES.
LOWER ILLINOIS, UTICA TO MOUTH OF RIVER.		
AREA IN RIVER-BED.....	28,811.4 A.	
AREA IN PONDS & BACKWATER.....	49,404.5 A.	
TOTAL 78,215.9 ACRES.		
AREA UNDER FLOOD, 1904.....	285,853.0 A.	
ADDITIONAL " " " 1844 (APPROX.).....	63,644.0 A.	
TOTAL AREA. 349,297.0 ACRES.		
TOTAL AREA OVERFLOW..... 361,126.0 ACRES.		

CHICAGO CITY DATUM IS THE MEAN LEVEL OF LAKE MICHIGAN FOR EIGHT MONTHS (APRIL TO NOVEMBER) OF 1847.  
LOW WATER 1819 = -1.93. HIGH WATER 1838 = +4.74.

MEAN SEA LEVEL.

ST. LOUIS

CHICAGO

CHICAGO CITY DATUM

ILLINOIS RIVER

LOWER ILLINOIS RIVER

RIVER

UPPER ILLINOIS RIVER

DES PLAINES RIVER

LAKE MICHIGAN

180 FEET ABOVE GULF OF MEXICO

GRAPH BY THOS. F. PARRY

*The Alluvial Lands of the Valley* represent the spoils of the uplands deposited in the bed of the old outlet. Below Utica the modern stream is a survival shifted to the side opposite detritus-bearing tributaries, with large inter-spacial lakes, ponds and sloughs. A remnant of the ancient stream-bed survives in Lake Peoria, a mile in width, with an average of three-fourths mile for seventeen (17) miles, which has not yet been suppressed by contributions from above. The Lower Illinois River is not a normal expression of river forces, its banks are relatively low and its bed is ill-formed or in process of formation. Nature requires an era to shrink to a fit the bed of its great ancestor.

*The Upper Illinois Valley-Lands* are comparatively limited and the deep pool, ten and one-half ( $10\frac{1}{2}$ ) miles in length between Sugar Island and Kickapoo Reef in the Morris-Marseilles reach, is a survival. The Desplaines River is still more primitive. The ponds and expanses of the twelve (12) mile level between Lyons and Lemont were but partially filled. There was little alluvium on the rock floor from Lemont to Joliet, and Lake Joliet and Lake Dupage are obvious remnants of the old outlet.

*The Profile* from dam No. 1 at Joliet, to the confluence with the Kankakee River, shows the depths from the earliest surveys by John B. Preston, 1857-8, to the latest by the Barlow Board in 1899. Lake Joliet is a rock-bound pool excavated at the foot of rapids having a descent of over seventy (70) feet. It has an average width of six hundred (600) feet and a length of five and four-tenths (5.4) miles, while the "oldest inhabitant" gave it a depth of forty (40) feet. The comparative profiles of bottom show the



rapid deterioration which has occurred since tillage became general, but we have no information respecting conditions since the Drainage Canal was opened in 1900.

4. *The Population* immediately concerned in the Illinois Route is as follows:

FEDERAL CENSUS, 1910.

Description	Urban	Rural	Totals
Sanitary District of Chicago . . . . .	2,256,771	55,039	2,311,810
Illinois Valley, 10-Mile Limit . . . . .	208,679	237,149	445,828
Illinois Basin Additional . . . . .	158,652	991,263	1,149,915
Totals . . . . .	2,624,102	1,283,451	3,907,553
Total, State of Illinois . . . . .	3,476,929	2,161,662	5,638,591

*The Sanitary District* population is forty-one per cent (41%) of that of the State, and its Urban population sixty-five per cent (65%) of that of the State.

*The Illinois Route* population (Sanitary District and the ten-mile limit) is forty-nine per cent (49%) of that of the State, and its Urban population is seventy-one per cent (71%) of that of the State.

*The Illinois Basin* population (including that of the Sanitary District) is sixty-nine and one-half per cent (69½%) of that of the State, and its Urban population is seventy-five and one-half per cent (75½%) of that of the State.

*The Indiana-Calumet* population in the Urban dis-



THE SANITARY DISTRICT OF CHICAGO.

*Sydney Hooley* CONSULTING ENGINEER.

# DESPLAINES RIVER FROM JOLIET TO ILLINOIS RIVER.

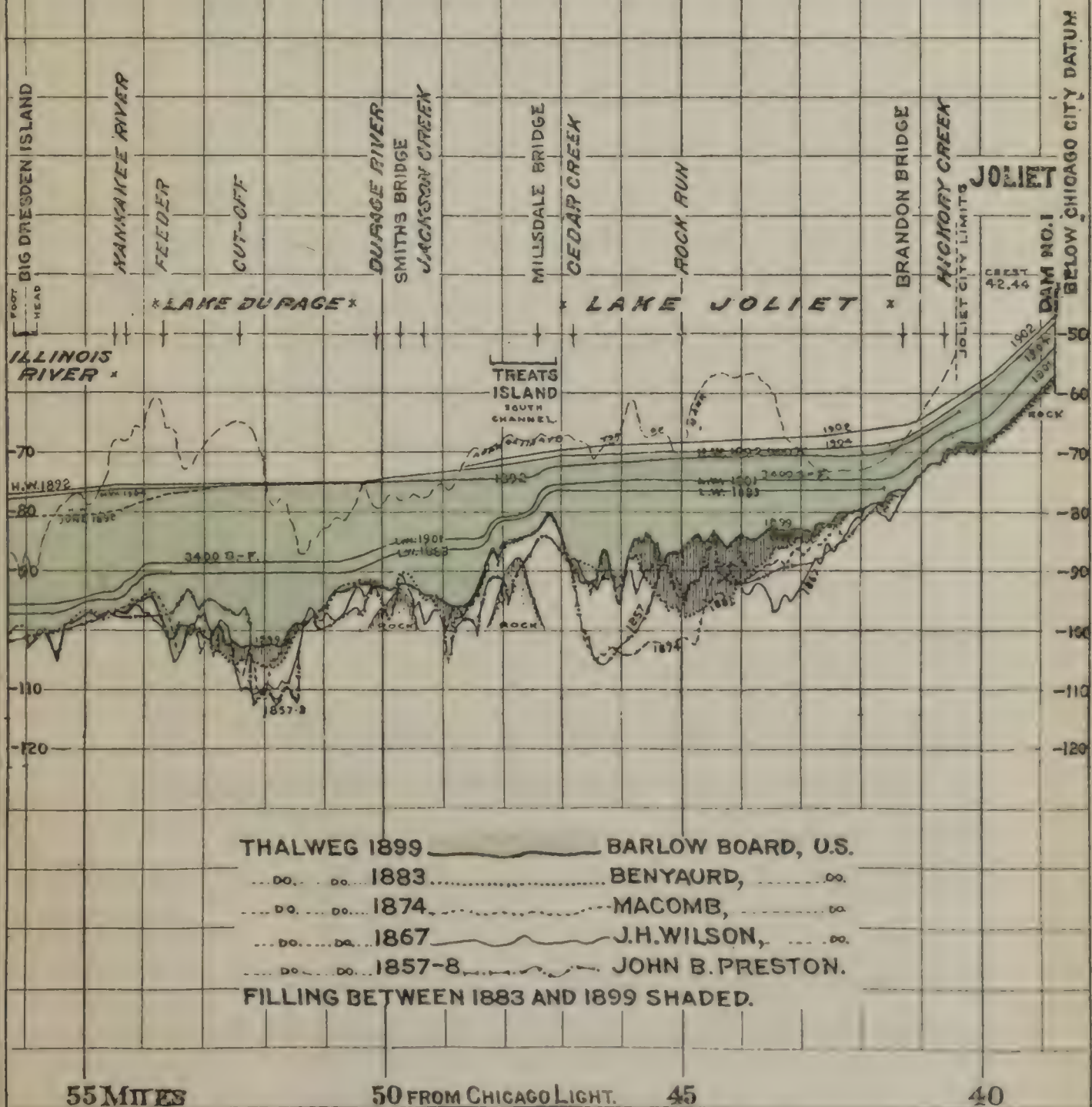
COMPARISON OF RIVER-BEDS AND FLOW-LINES SINCE 1857-8.

SCALES.

HORIZONTAL 0 1 2 3 4 5 MILES.  
VERTICAL 0 10 20 30 40 50 FEET.

DECEMBER, 1913.

DRAWN BY THOS F. PARRY.







tract adjacent to the State line has a related interest and numbers sixty-four thousand nine hundred forty-eight (64,948), located in Hammond, Whiting, East Chicago and Gary.

*The Population Data* manifest the paramount importance of the Illinois Route and of everything concerning its development.

5. *Surveys and Reports* respecting the Illinois Route, in whole or in part, have been made as follows:

(1.) 1823-36, Illinois and Michigan Canal—Sundry surveys and projects for location, treatment and capacity, beginning with Post and Paul, 1823-4.

(2.) 1838, Lower Illinois River—Examination and report on low water improvement by Capt. Howard Stansbury.

(3.) 1857-8, Illinois Route—Lake Michigan to Mississippi River—Maps, profiles and notes by the late John B. Preston, bought for the State of Illinois by Governor Oglesby in 1866 and placed at the disposal of the Federal engineers. Preston is credited with the steamboat project adopted in later reports.

(4.) 1861, Illinois Route—Examination by Canal Trustees ordered by the General Assembly. Report not found.

(5.) 1866-7, Illinois Route—Lake Michigan to the Mississippi River. Examination and report by General J. H. Wilson (February 15, 1867), based largely on the Preston data. Steamboat Channel seven (7) feet deep.

(6.) 1867-8, Illinois Route—Lake Michigan to the Mississippi River—Report and project by Wilson

and Gooding (December, 1867), from new surveys and data in 1867. Locks seven (7) feet deep.

(7.) 1874-5, Lake Michigan to Hennepin, survey by Col. J. N. Macomb—Northern Transportation Route, etc. Depth seven (7) feet and above.

(8.) 1879-80, Lower Illinois River, Copperas Creek to the mouth—Survey and report by Capt. J. G. Lydecker on project for Federal dams at La Grange and Kampsville. Locks seven (7) feet deep.

(9.) 1882-3, Illinois and Michigan Canal—Report by Major W. H. H. Benyaurd on enlargement to conform to the Hennepin Canal Project.

(10.) 1883-4, Upper Illinois River—Joliet to La Salle. Survey and Report by Major W. H. H. Benyaurd on project for river improvement; lock depth seven (7) feet.

(11.) 1886-7, Chicago to Mississippi River by Hennepin Canal Route—Report of Comstock Board (U. S.) favors improvement of river from Joliet to La Salle.

(12.) 1889-90, Upper Illinois River, Lockport to La Salle—Survey and Report by Capt. W. L. Marshall on fourteen-foot project with general discussion of Illinois Route. Survey of 1883 used below Joliet.

(13.) 1899-1900, Upper Illinois River, Lockport to La Salle—Surveys and Report by Barlow Board (U. S.) and opinion on feasibility of fourteen (14) foot waterway for the Illinois Route.

(14.) 1902-5, Illinois Route, Lockport to St. Louis—Survey and Report by Ernst Board (U. S.) on fourteen (14) foot project with estimate of cost. Survey exhaustive and cost two hundred thousand dollars (\$200,000).



(15.) 1907, Lakes and Gulf Waterway—Internal Improvement Commission of Illinois—Review of data and project for an ultimate depth of twenty-four (24) feet, with water power development, Lockport to Utica, and progressive development in the Lower Illinois for depth greater than fourteen (14) feet. This Report underlies the Constitutional Amendment of 1908.

(16.) 1907-9, Lakes and Gulf Waterway—Examination and Report by Bixby Board (U. S.) on fourteen (14) foot project, St. Louis to Gulf—Project of Ernst Board (1905) followed, Lockport to St. Louis.

(17.) 1910-14, Lake Michigan to Cairo and Lake Levels—Special board on co-operation with Illinois and on certain dams in the Mississippi River. Provisional Report of February 9, 1911, which was withdrawn by President's Message of December 21, 1911, and board continued by Congress for conference with a properly constituted agency of the State of Illinois. The General Assembly has made no provision for such conference. The final report, August 15, 1913, passed the Reviewing Board, February 17, 1914, and was available to the public in May, 1914.

(18.) 1886-1913, The City of Chicago and the Sanitary District of Chicago have made special and elaborate surveys and examinations respecting physical conditions between Lake Michigan and the Mississippi River and the sanitary relation of the deep waterway project.

Collateral and supplemental examinations and reports, in addition to the above, have been made by the United States, the State of Illinois and municipal agencies. The data have also been digested in rela-

tion to economic problems by a number of voluntary associations.

6. *The Sanitary District of Chicago* was organized under "An Act to Create Sanitary Districts," etc. (in force July 1, 1889). The Main Channel of the District was defined in a deep waterway specification and is declared to be a navigable stream. This Act and its Amendments, contemporary legislation respecting State dams and the joint resolutions of 1889 and 1897, define a deep waterway policy for the Illinois Route, to be worked out through the aid of a large water supply from Lake Michigan at Chicago and without obstructing dams in the alluvial river below Utica.

*The Main Channel* of the Sanitary District has a length of thirty (30) miles between the waters of the Chicago River at Robey Street and the water power plant between Lockport and Joliet, a depth of twenty-four (24) feet or more, and a capacity of fourteen thousand (14,000) second-feet, except seven and eight-tenths (7.8) miles in the clay between Summit and Robey Street, which is subject to progressive development. This section had an original capacity of sixty per cent (60%) of the completed channel, but is now undergoing enlargement. A deep channel has also been made for two and one-tenth (2.1) miles from the power plant to the Upper Basin at Joliet, and the river improved thence to Lake Joliet. The Chicago River improvement, six (6) miles in length, between Robey Street and Lake Michigan, is nearing completion, and this, together with the Thirty-ninth Street conduit, has an estimated capacity of ten thousand (10,000) second-feet. Further adjuncts, together with the Sag Channel now under



way, will provide for the full capacity of fourteen thousand (14,000) second-feet. The capacity of the Illinois and Michigan Canal is also available.

*The Preliminary Flow of Water* in the Main Channel was established January 17, 1900, and the volume passing through the same has ranged from thirty to sixty per cent (30 to 60%) of its full capacity. The Federal Permit was based on the capacity of the Chicago River, as determined by various experimental volumes prior to 1902, and is for four thousand one hundred sixty-seven (4,167) second-feet. The Secretary of War, by virtue of the Act of March 3, 1899, refused a permit for a greater volume, and has enjoined the District (1912) and the issues are now in Court.

7. *The Upper Illinois River* was taken under particular advisement by the State, following the exhaustive surveys and report by the Ernst Board in 1905. The General Assembly provided for (1905) the Internal Improvement Commission, which reported a revised project in 1907. Four dams and pools were to be developed between the power station at Lockport and the Illinois River at Utica, all structures to be designed for an ultimate depth of twenty-four (24) feet, or for the same depth as the Drainage Canal. The Joliet level was to be constructed with this depth at the outset, but the three levels below were to be progressively developed from a preliminary depth of fourteen (14) feet. Water power was to be developed at the several dams under public ownership. The General Assembly in adjourned session, October, 1907, submitted the Constitutional Amendment authorizing the expenditure of twenty million dollars (\$20,000,000) for waterway and water

power development in the Upper Illinois Valley and the Amendment was approved by popular vote in November, 1908. The promoters of the Amendment estimated that this amount would be sufficient to cover the development of the several levels and the water power and possibly the bridges.

The Lower Illinois River improvement was regarded as the province of the general government. It was assumed that the contribution of the Main Channel of the Sanitary District and the State work in the Upper Illinois would assure Federal co-operation in the Upper Illinois work and a deep channel for the Lower Illinois. Congress actually made a conditional appropriation of one million dollars (\$1,000,000) in 1910.

*The General Assembly*, in October, 1907, also provided for action for the removal of water power trespassers in the Upper Illinois valley and the decision of the State Supreme Court in 1909 is now on appeal to the U. S. Supreme Court.\*

The United States, in 1910, also instituted action on its own behalf and the case was submitted in February, 1913, and is still under advisement by Federal Judge Landis. The Legislature has been indisposed to authorize the expenditure of the twenty million dollars (\$20,000,000) until the character of the stream is determined in the court of last resort and until the flow of water which makes the deep waterway both possible and necessary, is established beyond recall.

---

\*Decided June 22, 1914. State of Illinois not the proper party to raise the Federal question.—(Ed.)



### **B—The Alluvial Valley of the Illinois.**

8. *The Lower Illinois River* is very direct in its course, not greatly exceeding the length of its valley, and it is two hundred and thirty (230) miles from Utica to Grafton.

Its natural low water declivity is taken at twenty-eight (28) feet but varies greatly with the stage of water in the Mississippi, where flood stages have exceeded in elevation the low water level at Utica.

The stream bed varies greatly in width and the channel is best formed and defined through and opposite the alluvial deposits from tributaries, but elsewhere has a remnant character inherited from the old outlet.

The average low water width, under present conditions, with the four dams, is one-fifth ( $1/5$ ) of a mile and is distributed as follows:

Location.	Distance (Miles)	Average Width	Area (Acres)
Utica to Lake Peoria (2 miles below Chillicothe) .....	50.2	866'	5,307
Lake Peoria (to Peoria).....	17.1	3,807'	7,894
Lake Peoria to Havana.....	42.6	602'	3,109
Havana to La Grange.....	42.2	682'	3,496
La Grange to Mouth of River.....	75.6	982'	9,006
Total .....	227.7		28,812

*The Bank Hight* above original low water varies from eight to fifteen (8 to 15) feet and has a general average of twelve (12) feet, or about half the height of extreme flood.

*The Bank Full Capacity* of the natural river as

estimated from measurements made in and prior to 1889 (Report 1890-U. S. and Sanitary District) is eighteen to twenty thousand (18,000 to 20,000) second-feet down to Havana, increasing to thirty thousand (30,000) second-feet at La Grange and to forty thousand (40,000) second-feet near the mouth; in other words, this capacity was from one-fifth to one-third ( $1/5$  to  $1/3$ ) of extreme flood (omitting 1844 and 1858) and one-fifth to one-fourth ( $1/5$  to  $1/4$ ) of what such floods would be under levee control. This may be contrasted with alluvial streams like the Missouri and the Mississippi, where the bank full capacity is about two-thirds ( $2/3$ ) of the normal extreme flood. The effect of volume on a stage of water is discussed in later topics.

*The Natural Low Water Volume* is taken, in the later reports, at five hundred (500) second-feet for the upper half of the river and one thousand (1,000) second-feet below the central basin. (Sangamon River, etc.).

*The Flood Hights of 1844* are the greatest of record and may be compared with 1904, which is taken as the normal extreme in recent years for the entire river. The following figures give range above low water:

Place.	1844.	1904.	Diff.
Utica .....	30.3'	26.2'	4.1'
Peoria .....	26.9'	23.1'	3.8'
Havana .....	21.9'	19.7'	2.2'
Beardstown .....	22.7'	20.1'	2.6'
Pearl .....	26.5'	19.5'	7.0'
Grafton .....	31.42'	22.4'	9.0'



The flood of 1904 was exceeded by the flood of 1883 opposite the central basin and the flood of 1913 was continuously higher from the central basin to the mouth. The flood lines show the effect of the wide bottoms opposite the central basin and thence to the mouth, in diminishing the flood range; and again, backwater from the Mississippi largely increases the range of some of the great floods near the mouth.

*The Flood Volume of 1904*, as measured at Pearl, is one hundred seventeen thousand (117,000) second-feet and the equivalent is estimated at one hundred fifteen thousand (115,000) for Beardstown, one hundred thousand (100,000) for Havana and ninety thousand (90,000) second-feet at Peoria and eighty-five thousand (85,000) second-feet at Ottawa (Report of the Ernst Board, U. S. 1905, p. 8).

9. *The Character of the Valley Lands*, as described in official reports, is shown by the following excerpts: Howard Stansbury, 1838—(U. S. Topographical Engr.) “The bottom lands extend from one to five miles on each side of the river, seldom rising more than a few feet above the level of the stream in its ordinary stages, and from the fact that they are constantly overflowed, by every freshet, to a depth varying from one to fifteen feet, are now and must ever remain uninhabited. Hence the river presents the appearance of flowing through an ancient, vast and solitary forest, clothed with a foliage rich and luxuriant beyond description, where solemn silence has never been broken, save by the howl of the panther, or the still more savage yell of the red-man. It was upon this stream that the first settlement was made by the French emigrants from Canada,



and here from the salubrity of the climate, the surpassing beauty of the scenery and the richness of the soil, they promised themselves the possession of a second paradise." \* \* \* "Its banks consist almost entirely of very low alluvial bottoms, skirted by lagoons or lakes, most of which are connected with the river, the whole overflowed by every freshet for several miles on each side." Gen. J. H. Wilson, February, 1867—(U. S. Engr.) "With a sluggish current \* \* \* the river wanders through a valley of swampy land varying in width from one and a half ( $1\frac{1}{2}$ ) to six (6) miles." Again, "the straight reaches are almost invariably deep with a muddy bottom, the shallows occur at the elbows, at confluent channels and at the mouths of creeks."

Wilson and Gooding, 1867-8, (Dec. 17, 1867—U. S. Board). "The depths are reduced almost every season, upon the shoals in the bed of the stream, until they do not exceed an average of twenty (20) inches, thus, in fact, suspending navigation for periods ranging from sixty (60) to ninety (90) days."

Again, "There has been scarcely a season since the canal was completed, twenty (20) years ago, when there has not been a serious interruption to navigation, for a greater or less period, from low water in the river, and as the country has improved, so that the surface water which formerly drained more slowly and continuously into our river has ceased to afford any considerable supply in summer, the evil has become worse."

Capt. W. L. Marshall, 1890 (U. S. Engr.): The bottom lands are "cut up by numerous sloughs, lagoons and ponds." Again, "At about the nine (9) foot



stage \* \* \* the basins and lagoons begin to fill, at ten (10) or eleven (11) feet the lowest areas, worthless for cultivation, begin to be submerged, and at about the twelve (12) foot stage, overflow begins to be widespread. At about the sixteen (16) foot stage, probably eight-tenths (8/10) of all lands submerged at extreme floods are covered with water." Further, respecting low water, "The *natural* low-water volume of the Illinois is gradually diminishing, from various causes," etc.

*All Reports* give minimum bar depths of eighteen (18) to twenty (20) inches. The Wilson Reports catalogue forty-one (41) localities with bars of less than five (5) feet but find only ten (10) bars of less than two and one-half ( $2\frac{1}{2}$ ) feet as against sixteen (16) by Stansbury in 1838. Congress made an appropriation of thirty thousand dollars (\$30,000) in 1852 which was expended in dredging by Col. Joseph E. Johnson (late of Confederate fame) in 1854, and the results obtained were effective during the Wilson surveys of 1866-7.

**10.** *The Area of the Valley* at an horizon fifteen (15) feet above the high water of 1904, substantially the foot of the bluffs, is seven hundred and seventeen (717) square miles (460,000 acres). The area under the high water of 1904 is five hundred sixty-eight and fifty-four hundredths (568.54) square miles, (363,870 acres) of which forty-five and two hundredths (45.02) square miles (28,812 acres) are in the river bed (Topic 8), and seventy-seven and nineteen hundredths (77.19) square miles (49,405 acres) in ponds, etc., leaving a land area above the low water of 1901 of four hundred forty-six and thirty-three hun-

dredths (446.33) square miles (285,653 acres). The additional area within the fifteen (15) foot limit is one hundred forty-eight and forty-six hundredths (148.46) square miles (95,014 acres), two-thirds ( $\frac{2}{3}$ ) of which is presumed to be covered by the flood of 1844. The data are compiled in detail from the maps of the U. S. Survey of 1903-4 in the Report of the Internal Improvement Commission of Illinois for 1907. The following table gives the results for characteristic reaches:

Description.	Utica to Havana (Spoon River)	Havana to La Grange Dam.	La Grange to Mouth of River.	Valley.
Distance, Miles .....	109.9	42.2	77.5	229.6
River Bed, Acres.....	16,310	3,496	9,006	28,812
Ponds, Sloughs, etc., Acres...	20,929	16,258	12,218	49,405
Lands covered in 1904, Acres	96,021	77,893	111,739	285,653
Between 1904 and 1844, Acres (approximately) .....	18,180	17,750	27,712	63,642
Totals, Acres .....	151,440	115,397	160,675	427,512

*The Width of the Valley* varies from one and one-half ( $1\frac{1}{2}$ ) to six (6) miles, and, including forty-nine and seven-tenths (49.7) square miles above the flood of 1844, the average width within the bluffs may be computed from the foregoing figures as follows: Utica to Havana, two and twenty-eight hundredths (2.28) miles, Havana to La Grange, four and sixty hundredths (4.60) miles, and from La Grange to the mouth, three and fifty-two hundredths (3.52) miles.

*The Tributary Watershed* for the three reaches is compiled as follows (compiled from Water Supplies of Illinois, 1889):



Basins	Sq. Mi.	Sq. Mi.
UPPER ILLINOIS RIVER.....		10,365
UTICA TO HAVANA .....		5,219
Vermilion River .....	1,317	
Bureau Creek .....	480	
Kickapoo Creek .....	310	
Mackinaw River .....	1,217	
Other Drainage .....	1,895	
HAVANA TO LA GRANGE.....		9,535
Spoon River .....	1,870	
Sangamon River .....	5,670	
Crooked Creek .....	1,385	
Other Drainage .....	610	
LA GRANGE DAM TO THE MOUTH.....		2,795
McKees River .....	472	
Apple Creek .....	525	
Macoupin Creek .....	985	
Other Drainage .....	813	
ILLINOIS RIVER BASIN.....		27,914

*The Ratios of the Areas* of land, of the ponds, etc., and of the river, to the total areas under the flood of 1904, together with the additional area between 1904 and 1844, are shown as follows:

Description.	Utica to Havana.	Havana to La Grange.	La Grange to Mouth.	Valley.
Total per cent.....	100%	100%	100%	100%
Lands above low water, 1901..	72.2	79.8	84.0	78.5
Ponds, etc., outside river bed..	15.6	16.6	9.2	13.6
River Bed .....	12.2	3.6	6.8	7.9
Additional area, 1904-1844.....	13.6	18.1	20.8	17.4

It will be noted that the aggregate area of land is seventy-eight and five-tenths per cent (78.5%), of ponds, etc., thirteen and six-tenths per cent (13.6%), and of the river bed seven and nine-tenths per cent (7.9%). In other words, the water area outside the

river is nearly double that in the river bed. The additional area between the flood of 1904 and that of 1844 is seventeen and four-tenths per cent (17.4%). Again the proportion of land is least in the upper reaches and the same is true of the lands between the flood of 1904 and 1844. The proportion of area in the river bed is greatest in the upper reach and least in the middle reach, while the proportional area in ponds is greatest in the middle reach and least in the lower reach.

*The Alluvial Deposits* are evidently the greatest and most systematic in the middle and lower reaches, due to more active surface erosion in the central basin and lower tributaries, and the impounding effect of high stages in the Mississippi. Some thirty-four per cent (34%) of the watershed is tributary to the middle reach and ten per cent (10%) additional to the lower reach and the flood regimen is akin to that of the Mississippi and distinctive from that of the Upper Illinois; in fact, floods from the central basin have backed over the dam at Copperas Creek. The floods of 1883 and 1913 were greatly accentuated from the central basin to the mouth.

*The Alluvial Deposits* in the upper reach between Utica and Havana are comparatively meagre as shown by the relatively lower bottom lands, large pond areas, wide and ill-defined river bed, low declivity and the unfilled expanse of Lake Peoria. The Upper Illinois drainage is greater than that of the central basin, some thirty-seven per cent (37%) of the total, while the drainage locally tributary is only nineteen per cent (19%). The unfilled remnant pool above Marseilles and the character of the Fox River drainage, indicate small contribution of detritus to



the lower river at Utica. The contributions from the two Vermilions, Bureau Creek and local streams, two thousand one hundred twenty-four (2,124) square miles, together with the supply from the Upper Illinois, have filled in the valley locally, but in a distance of nearly fifty (50) miles between Hennepin and Peoria, the drainage is less than one thousand (1,000) square miles, and the supply of detritus has not been sufficient to produce continuous bottom lands and to define the river bed. The effect of the tributaries at Peoria and below is most notable in producing locally the narrowest and best defined river and the activity of Farm Creek has been the subject of Congressional inquiry, but in the approach to Havana the conditions existing above Peoria are resumed.

**11.** *The Duration of Floods* is greatly prolonged owing to the small capacity of the stream bed and the limited heights of banks in comparison with normal rivers. For every day the river is out of banks in the upper river at Morris (ten feet above low water) the river is out of banks (twelve feet above natural low water) for six (6) to eight (8) days between Peru and Copperas Creek and twenty per cent (20%) longer at La Grange, the period increasing down stream through non-coincident floods from the central basin and back water from the Mississippi. The reclamation of the overflow lands will produce a profound change in the flood regimen.

*The Low Water Stage* for a period of eleven years prior to the erection of the federal dams was less than two (2) feet above extreme low water for an average of forty-two (42) days at Copperas Creek

which may be taken as a measure for the upper half of the river, and sixty-two (62) days at La Grange which may be taken as the measure for the lower half of the river. The ordinary dry weather flow has been affected through the reclamation of swamps and in later years has been sustained largely by the great swamp areas in the Kankakee Basin and by the lakes in the Fox Basin and also by the large pondage in the bottom lands. When these are drained in long dry periods, extreme low water follows, but is usually of short duration.

The eventual drainage of the Kankakee marsh system and the reclamation of the bottom lands and ponds may be compensated, in some degree, by sub-surface flow, but in any event, a profound change will be produced in the low water regimen.

*The Extreme Low Water* volume of dry years is about one-half of one per cent ( $\frac{1}{2}$  of 1%) of the average yearly runoff, a most remarkable condition in the humid region, and this evidences the consuming power of vegetal cover and the paucity of sub-surface flows, due to impermeable sub-soils.

*The Runoff* of the Illinois Basin varies greatly with the climatic, surface and vegetal conditions, and with the years. Changes due to reclamation and tillage have been noted in official reports (See Topic 9; also Topic 15) and a difference in flood regimen seems to be made out for the last half of the period of inhabitation but no sufficient data have been gathered respecting runoff. The report of the Internal Improvement Commission of Illinois for 1907 assumed the average run-off at three-fourths ( $\frac{3}{4}$ ) second-feet per square mile or intermediate between



that of the upper Mississippi Basin and the Lake Basin, but later figures have reduced the Lake Basin determination so that seven-tenths ( $7/10$ ) second-feet per square mile would be a better assumption. Mr. Jacob Harmon (State Board of Health—Report on Sanitary Investigations 1901) determined the run-off at Peoria for the ten-year period 1890-9, prior to the opening of the Sanitary Canal at Chicago. The basin area is taken at thirteen thousand, four hundred and eighty square miles (13,480) and the normal rainfall is given at thirty-three and fifty-two hundredths (33.52) inches. The average flow is found to be eight thousand, three hundred ninety-one (8,391) second-feet, equivalent to eight and forty-six hundredths (8.46) inches in depth and six hundred twenty-two thousandths (0.622) second-feet per square mile. Lake Michigan water through the Illinois and Michigan Canal is taken at six hundred (600) second-feet which would reduce the flow from the basin to seven thousand seven hundred and ninety-one (7,791) second-feet equivalent to seven and eighty-six hundredths (7.86) inches in depth or five hundred and seventy-six thousandths (0.576) second-feet per square mile. This decade represents the lowest rainfall and the most remarkable drought which has occurred since inhabitation and the results are below normal. It appears that the average run-off is about half bank full capacity of the stream in its original condition.

*Contributions from Lake Michigan* have been made since the Illinois and Michigan Canal was opened in 1848. The Acts of Congress of 1822 and 1827 authorized a new outlet, or rather, the partial restoration of the old one (Missouri case U. S. 200, p. 518).

The Summit level of the canal was fed in part through a pumping station at Bridgeport, but the Summit level was cut down in 1865-71 according to the original plan, and the flow of water finally established by gravity. This flow was reinforced by pumping works at Bridgeport in 1881-6, which continued in operation after the Main Channel was opened January 17, 1900. The yearly average flow through the Main Channel of the Sanitary District has been as follows:

Year—	Cubic feet per second.
1900 .....	2,989
1901 .....	4,041
1902 .....	4,302
1903 .....	4,971
1904 .....	4,693
1905 .....	4,477
1906 .....	4,471
1907 .....	5,117
1908 .....	5,317 (approx.)
1909 .....	5,666 “
1910 .....	5,966 “
1911 .....	6,453
1912 .....	6,377
1913 .....	7,193

**12.** *The Reclamation of the Bottom Lands* is a recent undertaking. In 1838, Capt. Stansbury expressed the opinion that they must “ever remain uninhabited.” In 1867, Gen. Wilson states: “This may be true, until a denser population gives a sufficient value to the land to justify a reclamation by levees. Already, cultivation has begun to encroach on the bottoms.” In 1890, Capt. Marshall reports, “A large area of the higher parts of the bottoms



is cultivated whenever not submerged before seed-  
ing time, and the cultivated area is annually increas-  
ing." Prior to 1900, a number of areas were en-  
closed by levees, but it is only within the last decade  
that these works took on a substantial character and  
have been supplemented by pumping works, thus es-  
tablishing a standard practice. The districts usually  
enclose areas of several thousand acres, between  
tributaries and fronting on the river. The present  
extent of these districts is given by Mr. Jesse Lowe  
(organizer and first president of the Drainage and  
Levee Association of Illinois), Beardstown, Illinois,  
under date of December 24, 1913.

#### DRAINAGE AND LEVEE DISTRICTS.

Lands.	Utica to Havana.		Havana to La Grange.		La Grange to Mouth River.		Valley.	
	No.	Acres.	No.	Acres.	No.	Acres.	No.	Acres.
Under Levee .....	9	34,750	10	30,100	11	94,300	30	159,150
Undergoing Reconstruction ..	.....		6	49,400	2	3,700	8	53,100
Organizing and in Progress	1	3,000	2	11,385	..	.....	3	14,385
<b>Total .....</b>	<b>10</b>	<b>37,750</b>	<b>18</b>	<b>90,885</b>	<b>13</b>	<b>98,000</b>	<b>41</b>	<b>226,635</b>
Area under H. W., 1844, including Ponds .....	135,130		..	111,901	..	151,669	..	398,700 Excluding River Bed
Reclamation Percentage....	28%		..	76%	..	65%	..	57%

The districts now under levee, aggregate one hun-  
dred fifty-nine thousand, one hundred and fifty (159,-  
150) acres or thirty-nine per cent (39%) of the total  
bottom lands between the river bed and the H. W. of  
1844. The second item, fifty-three thousand one hun-  
dred (53,100) acres represent districts under the  
Farm Drainage Act that are putting in pumping

plants or building or reconstructing levees, one-half ( $\frac{1}{2}$ ) of which is estimated to be now under levee. The total under levee and in progress is two hundred twenty-six thousand, six hundred and thirty-five (226,635) acres or fifty-seven per cent (57%) of all the lands between the river bed and the H. W. of 1844. Experience shows that the average cost of complete reclamation by means of levees and pumping works is about fifty dollars (\$50.00) per acre, so that the full development of the districts above scheduled represents an investment above the cost of the land of over eleven million dollars (\$11,000,000). The law allows an annual assessment of one dollar (\$1.00) per acre to cover maintenance and operation, and this item is usually less. So large a restriction of the overflow area must materially affect the flood height and this may have contributed to the extraordinary height of the flood of 1913 in the second (2d) and third (3d) reaches as well as the unusual run-off of the central basin and the lower tributaries.

*The Fisheries in the Waters of the Illinois* are the richest in the United States, apart from the sea. Prior to the opening of the Drainage Canal in 1900, the yearly catch varied from six (6) to fourteen (14) million pounds, but was unreliable by reason of long drought or ice cover, through which the oxygen content was exhausted and fish life decimated. The maintenance of a large volume of water has made a reliable industry and the catch had grown to forty-six million (46,000,000) pounds (census 1908) with a value of over eight hundred thousand dollars (\$800,000) on the banks and double to the consumer. This represents more than ten dollars (\$10.00) per



acre for all the water space in the Illinois Valley. Prof. Stephen A. Forbes, Chief of the Natural History Survey of Illinois, has otherwise stated the value as representing half a dollar yearly for each foot in the length of the Illinois River below the junction of the Desplaines and Kankakee. Prof. Forbes has further stated that the plankton in Illinois waters has multiplied from two (2) to three (3) times per unit of volume, but the yearly volume passing Peoria is now nearly double the average natural flow so that the basis for fish food is actually multiplied from four (4) to six (6) times. Fish culture in China is eloquent as to the results which may be accomplished through the fertilization of waters. ("Farmers of Forty Centuries", p. 93-5, King.) The State Fish Commission already controls certain ponds and back waters as spawning and feeding grounds and Prof. Forbes recommends that the State acquire and maintain certain reservations for this purpose in order that this source of wealth shall not be destroyed through the reclamation of all overflow lands outside the river bed, and improvement and restriction of the river bed itself for purposes of navigation. He also calls attention to the dams, especially at La Grange and Kampsville, in limiting fish migration. Sound economic policy will therefore limit reclamation for agricultural purposes and this will be conservative, not only of the wealth in fisheries, but will mitigate, in some degree, the overwhelming heights of floods which would follow the restriction of all waters to the immediate channel of the river.

*Improved Sanitary Conditions* throughout the Desplaines and Illinois Valley are only secondary in importance to the benefits at Chicago. The systematic

reclamation of overflow lands and the improvement of river beds is a radical contribution to the salubrity of the valley, its cities and adjacent uplands, and the maintenance of a large and uniform volume of water has the same relative value to the urban population for sewage disposal that it has for the Sanitary District of Chicago.

**13.** *Damages from Overflow* occasioned by the increment through the Drainage Canal is a liability against the Sanitary District and the plaintiff may recover his reasonable attorney's fees in case the judgment of the court exceeds the tender of the District (Sec. 19, Act to create Sanitary Districts, etc.) The amount paid in damages to December 31, 1912, for the entire river below the head of Lake Joliet, was one hundred forty-nine thousand, seven hundred and four dollars and fourteen cents (\$149,704.14), which includes twenty thousand eight hundred and three dollars and seventy-six cents (\$20,803.76) for removing two (2) feet from the crest of the Kamps-ville Dam and two thousand and seventy-eight dollars and forty-five cents (\$2,078.45) for land acquired along Lake Joliet. The Engineering Department has expended three hundred ninety-nine thousand, two hundred seventy-four dollars and forty-eight cents (\$399,274.48) in the investigation of conditions and preparation for defense in the Des-plaines and Illinois Valley. In addition, the Legal Department has expended large sums in defending suits which are not separately returned. The entire expenditure is between five hundred thousand (\$500,000) and six hundred thousand dollars (\$600,000).

*The Claims Pending in Court, December 31, 1912,* were as follows:



Divisions.	Permanent Damage.		Temporary Damage.		Total.	
	No.		No.		No.	
Utica to Havana.....	122	\$2,474,400	46	\$ 434,900	168	\$2,909,300
Havana to La Grange.....	2	33,330	108	1,118,350	110	1,151,680
La Grange to Mouth of River.	5	469,000	1	10,000	6	479,000
Totals .....	129	\$2,976,730	155	\$1,563,250	284	\$4,539,980

The claims in process of adjudication number two hundred and eighty-four (284) and amount to four million, five hundred thirty-nine thousand, nine hundred and eighty dollars (\$4,539.980). The additional claims preferred but not yet entered of suit will raise the total to about eight million dollars (\$8,000,000). It will be noted that the claims pertain most largely to the first reach, which contains the State dams and in which reclamation schemes are least developed, and further, the claims are least in the reach below La Grange, in which the Kampsville Dam has been cut down by two feet under a Federal permit, authorized by the joint resolution of Congress, April 21, 1904. Nothing was done at La Grange which controls the levels in the second reach in which the claims in court aggregate one million one hundred fifty-one thousand, six hundred and eighty dollars (\$1,151,680.00).

*The Early Value* of the lands was nominal, as may be inferred from citations heretofore given. The report of the undersigned in 1890 (Lakes & Gulf Waterway, 1891) based on extended inquiry, placed the value of these lands between two million five hundred thousand dollars (\$2,500,000) and three million seven hundred thousand dollars (\$3,700,000). A special party from the Engineering Department of

the Sanitary District made an exhaustive reconnaissance of several months in 1890 and again after the great flood of 1892 and placed the value of the lands at two million dollars (\$2,000,000) to three million dollars (\$3,000,000). In 1906-7, H. M. Schmoldt, lumber manufacturer, Beardstown, Illinois, (Member, Internal Improvement Commission) estimated that seventy-five thousand (75,000) acres would maintain a yearly output at his mills of four million (4,000,000) feet B. M. and that land values would have justified the investment a few years before had it then occurred to him. The purchase of all the overflow lands was actually mooted by the first Chief Engineer of the Sanitary District. It is interesting to note that the increased value of the fisheries which has followed the increment of water represents a return on many times the original value of the overflow lands. The Acts of Congress of 1822 and 1827 authorized the Illinois outlet (Missouri Case, U. S. 200-518) prior to the sale of any of these lands and presumably they are under servitude. The tentative report of the special Board of Engineers, of January 23, 1911, (H. R. 1374) contends that Illinois is bound by the Acts of 1822 and 1827, in its larger waterway purpose.

*The Rules of Law* governing the determination of damages have been defined by the Supreme Court as follows:

In the case of *Jones v. Sanitary District* (252 Ill. 591) the court held that the continuance or operation of a permanent structure is not necessarily injurious to land, but may or may not be so, depending upon whether the land was so situated that it might or



might not be damaged by the use and operation of Sanitary District works. The court held further, that the plea of the statute of limitations did not aver that the injury sued for was permanent and that therefore a recovery could be had for damages sustained by the plaintiff for a period of five years prior to the beginning of the suit.

In the case of *Brockschmidt v. Sanitary District* (260 Ill., p. 502) the court held that the duty of widening and deepening the Illinois River was not intended by the legislature to be cast upon the Sanitary District; that the Illinois River being a navigable stream and in part obstructed by Federal dams at La Grange and Kampsville, it could not be presumed that the legislature intended to compel the Sanitary District, among its other duties, to remove these dams. In other words, when the District had constructed its Main Channel of the flowage capacity required by its organic act and the work had been approved by the Commissioners appointed under Section 27 of said act, and the Governor had issued his permit to turn the water therein, it had complied with the requirements of the law. The Court held further, that the District having constructed and opened its channel as aforesaid was conclusive of the fact that the channel was not negligently constructed and therefore all the damages occasioned by reason of the construction of the channel and the flowage of the water therein, constituted a permanent injury within the meaning of the law for which the injured party must recover, once for all, in one action, and that a plea of the statute of limitations is a good defense to any action not brought within five years from the date of the opening of the Main Channel of the Sanitary District.

**C—The Upper Division of the Lower Illinois,  
Utica to Havana.**

14. *The Alluvial Valley* of the Illinois begins at Starved Rock, about one and one-half ( $1\frac{1}{2}$ ) miles above Utica Bridge, and this location has usually been taken as the site of the first lock in the Upper Illinois project. The Utica bridge, however, is generally taken as the convenient point of division between the upper and lower valley.

*The Upper Division* of the Lower Illinois extends from the Utica Bridge to Havana, a distance of one hundred nine and nine-tenths (109.9) miles, with a natural low water declivity of eight and two-tenths feet (8.2 feet), or nine-tenths ( $9/10$ ) of an inch per mile.

*The average low water* width of the river by the U. S. Survey of 1903-4 was: Utica to Peoria Lake, fifty and two-tenths (50.2) miles, eight hundred sixty-six (866) feet; Peoria Lake, seventeen and one-tenth (17.1) miles, three thousand eight hundred and seven (3,807) feet; Peoria to Havana, forty-two and six-tenths (42.6) miles, six hundred and two (602) feet.

*The natural low water volume* has been taken at both six hundred (600) and five hundred (500) second-feet in official projects and lower volumes have been estimated.

*The average run-off* has been taken at seven-tenths (0.7) second-feet per square mile of watershed which would give nine thousand four hundred and thirty-six (9,436) second-feet for Peoria, (13,480 sq. mi.), but the average run-off passing Peoria in a dry decade, 1890-99, omitting canal water, was estimated



(Harmon) at seven thousand seven hundred and ninety one (7,791) second-feet with a minimum of two thousand seven hundred and thirty-eight (2,738) second-feet in 1895.

*The flood volume* in 1904 was estimated at ninety thousand (90,000) second-feet at Peoria and this flood was the most characteristic and uniform since 1844 and has been taken as a standard.

*The bank full capacity* of the natural riverbed prior to the erection of the state dams has been estimated at eighteen thousand (18,000) to twenty thousand (20,000) second-feet.

*The Area* under the flood of 1844 has been estimated as follows:

	Acres.
Lands between 1844 and 1904.....	18,180
Lands under 1904 .....	96,021
Ponds, sloughs, etc.....	20,929
Riverbed, including Peoria Lake....	16,310
Total, 151,440 acres or 236.6 sq. mi.	

*Reclamation Work* developed or now in progress is as follows:

County.	Districts.	Acres.	County Acres
Putnam .....	Hennepin .....	2,500	2,500
Woodford .....	Partridge .....	3,000	3,000
Peoria .....	Pekin and La March..	2,500	2,500
Fulton and Peoria.....	Banner Special .....	5,000	5,000
Fulton .....	Otter Creek .....	3,700	
“ (Organized) ....	West Matansas .....	3,000	6,700
Tazewell .....	East Peoria .....	750	
“ .....	Cummings .....	1,200	15,950
“ .....	Spring Lake .....	14,000	
Mason .....	Spoon River .....	2,100	2,100
Total Acres .....			37,750

*Damage Claims* against the Sanitary District under adjudication are as follows:

Counties.	No.	Permanent.	No.	Temporary.	No.	Total.
La Salle . . . .	29	\$ 629,500	3	\$ 31,000	32	\$ 660,500
Bureau . . . . .	14	346,600	4	7,500	18	354,100
Putman . . . . .	17	288,000	21	227,500	38	515,500
Marshall . . . .	33	588,300	3	13,000	36	601,300
Woodford . . . .	3	28,500	5	76,400	8	104,900
Peoria . . . . .	12	132,500	2	17,000	14	149,500
Tazewell . . . .	13	411,000	..	.....	13	411,000
Fulton . . . . .	1	50,000	8	62,500	9	112,500
Total . . . .	122	\$2,474,400	46	\$434,900	168	\$2,909,300

*The Ratios* of leading quantities of the upper division to the whole valley are as follows:

Item—	Per Cent.
All areas under flood of 1844.....	35.4
Lands only under flood of 1904.....	33.6
Ponds, sloughs, etc. (Low water of 1901).....	42.3
Riverbed, including Lake Peoria (Low water of 1901) .....	56.6
Reclamation (Area in Drainage and Levee Districts .....	16.6
Damage Claims .....	63.8

It will be noted that this division includes about one-third ( $\frac{1}{3}$ ) the lands, one-half ( $\frac{1}{2}$ ) the water, one-sixth ( $\frac{1}{6}$ ) of the reclamation and two-thirds ( $\frac{2}{3}$ ) the claims for damages.

**15.** *Dams and Locks* in aid of navigation have been built by the state at Henry and Copperas Creek, thirty-three and five-tenths (33.5) miles and ninety-two and eight-tenths (92.8) miles respectively below Utica bridge and six and five-tenths (6.5) miles less below the mouth of the Illinois and Michigan Canal at La Salle-Peru.

*The Henry Dam and Lock* was constructed under authority of an Act approved and in force February



28, 1867, amended by an Act approved and in force February 25, 1869, said Act appropriating surplus canal revenues for the construction of a dam and lock between La Salle and Peoria, said lock to be not less than three hundred fifty (350) feet in length and seventy-five (75) feet wide, and otherwise providing a scheme of co-operation with the United States for the development of a through waterway. The dam was closed October 19, 1871, and the water covered the crest on October 29, and the lock was available for navigation. The low water of 1871 at this point is five-tenths (0.5) foot below the low water of 1867 and has since been used as the low water plane and is one hundred fifty and five-tenths (150.5) feet below Chicago datum by the survey of 1902-4. The crest of the dam is five hundred forty (540) feet in length and is six and five-tenths (6.5) feet above the low water of 1871, the depth at the lower mitre sill is five (5) feet below the low water of 1871 and the depth on the upper mitre sill is five and five-tenths (5.5) feet below the crest of the dam. The record low water at La Salle-Peru is in 1867, three and eighty-eight hundredths (3.88) feet on the lower mitre sill at lock 15, and one hundred forty-seven and eight-tenths (147.8) feet below Chicago datum by the survey of 1902-4, thus giving a low water declivity of two and seven-tenths (2.7) feet in twenty-seven (27) miles between the mouth of the canal and Henry. The crest of the Henry dam is three and eight-tenths (3.8) feet above this low water and the gauge records indicate an additional elevation at La Salle-Peru of two-tenths (0.2) to three-tenths (0.3) feet from declivity. The Utica low water level, six and five-tenths (6.5) miles above

has been taken at three and five-tenths (3.5) feet above low water at Henry and one hundred forty-seven (147) feet below Chicago datum, or three (3.0) feet below the crest of the Henry dam. The declivity elevation at the bridge is not ascertained, but appears to be four-tenths (0.4) to five-tenths (0.5) feet one and one-half ( $1\frac{1}{2}$ ) miles below.

*The Illinois and Mississippi Canal* (Hennepin) enters the pool nineteen and four-tenths (19.4) miles below the Utica bridge and is twelve and nine-tenths (12.9) miles below La Salle-Peru. The low water elevation of 1871 at the canal entrance is one hundred forty-nine and one-tenth (149.1) feet (Approx.) below Chicago datum. The lower mitre sill of the first lock (canal bottom) is one hundred forty-nine and seven-tenths (149.7) below Chicago datum, or six-tenths (0.6) foot below natural low water and five and seven-tenths (5.7) feet below the crest of the Henry dam. The official depth of the canal is seven (7) feet. (Official Map, Illinois and Mississippi Canal, Hennepin, 1908—Hennepin datum is four hundred thirty-four and three hundred fifty-five thousandths (434.355) on Memphis datum as used on survey 1902-4).

*Copperas Creek Dam and Lock* was constructed under authority of an Act approved April 17, 1873, and in force July 1, 1873, said Act appropriating surplus canal revenues (including Henry lock) for the construction of a dam and lock, said lock to be no less than three hundred fifty (350) feet long and seventy-five (75) feet wide as part of a scheme for improvement of the river by five (5) dams and locks. The United States co-operated by constructing the



foundations for the lock (see below). The dam was closed October 21, 1877, and the water covered the crest on October 22 and the lock was then available for navigation. The low water of 1873 at this point was five-tenths (0.5) foot (assumed to be the same as at Peoria and Henry) below the low water of 1867 and has since been used as the low water plane and is one hundred fifty-four and three-tenths (154.3) feet below Chicago datum by the survey of 1902-4. The crest of the dam is six hundred and forty (640) feet in length and is six and twenty-five hundredths (6.25) feet above the low water of 1873, the depth of the lower mitre sill is five (5.0) feet below the low water of 1873 and the depth on the upper mitre sill is six and twenty-five hundredths (6.25) feet below the crest of the dam. The declivity at low water of 1873 (same as 1871 at Henry) was three and eight-tenths (3.8) feet in fifty-nine and three-tenths (59.3) miles, of which seventy-two hundredths (0.72) feet is in thirty-three and eight-tenths (33.8) miles between Henry and Peoria. The crest of the Copperas Creek dam is two and forty-five hundredths (2.45) feet above the low water of 1871 and 1873 at Henry, four and five-hundredths (4.05) feet below the crest of the Henry dam and seven and forty-five hundredths (7.45) feet above the lower mitre sill. At extreme low water the additional depth from declivity appears to be three-tenths (0.3) to five-tenths (0.5) foot by the gauge records.

*Below Copperas Creek to Havana*, seventeen and one-tenth (17.1) miles, the declivity is nine-tenths (0.9) foot (155.2 feet below Chicago datum) by the low water of 1879 which corresponds to 1873 at Copperas Creek.

*The La Grange Dam and Lock, U. S.*, is fifty-nine and three-tenths (59.3) miles below Copperas Creek dam, and was completed 1889-90. Its crest is seven and four-tenths (7.4) feet above low water of 1879 and corresponds to a level one-tenth (0.1) foot below low water at Copperas Creek. The declivity at low water in 1893 and 1894 was one and twenty-seven hundredths (1.27) feet with five-tenths (0.5) foot on dam at La Grange, and one and sixty-five hundredths (1.65) feet low water at Copperas Creek. Water at crest of La Grange dam thus corresponds to one and fifteen-hundredths (1.15) feet, more or less, at Copperas Creek.

*The Natural Low Water Plane* generally referred to is that of 1867 from Utica to La Salle-Peru; 1871—from La Salle-Peru to Henry; 1873—Henry to Copperas Creek dam, and 1879—below Copperas Creek, the same constituting a continuous low water line without break at points of division. The low water of 1871 at Peoria is one hundred fifty-one and twenty-two hundredths (151.22) feet below Chicago datum, which corresponds to the low water of 1873, 1874 and 1875, but as the Copperas Creek dam was closed in 1877, later dates are not available at this point. The low water of 1871 was five-tenths (0.5) foot below the low water of 1867, and one and four-hundredths (1.04) feet below the low water of 1866, 1852, 1845 and 1838, as shown by a permanent record on the bridge pier at Peoria (U. S. Survey, 1902-4). It thus appears that low water at Peoria underwent a radical diminution after 1866, notwithstanding a material increment from Lake Michigan after the canal deepening in 1866-71 and the Bridgeport



pumping works, erected in 1883-6. The record below Copperas Creek dam (1877) gives the low water of 1879 the same as 1871 and 1873, but the low years of 1894 and 1895 are masked by the Federal dams at La Grange (1889-90) and Kampsville (1893), and the Sanitary District increment masks the low water after 1899. It will be noted, in this connection, that the Wilson-Gooding Report of 1867-8 (U. S.) refers to a diminished low water due to upland reclamation, and Capt. W. L. Marshall in the report of 1890 recognizes the same condition; further, that a change in the flood regimen at Morris is indicated in the report of 1890 by the undersigned (Lakes & Gulf Waterway, 1891.)

*A Depth of Seven Feet* is not provided for by the State dams as ordinarily assumed and stated. The upper mitre sill at Henry is actually five and five-tenths (5.5) feet below the crest of the dam, but the zero of the upper gauge was set for six (6) feet on the theory of half ( $\frac{1}{2}$ ) a foot of water on the dam. The lower mitre sill at Henry is seven and forty-five hundredths (7.45) feet below the crest of the Copperas Creek dam and the low water declivity adds three-tenths (0.3) to five-tenths (0.5) foot. The upper mitre sill at Copperas Creek is six and twenty-five hundredths (6.25) feet below the crest of the dam, and the lower mitre sill is four and nine-tenths (4.9) feet below the crest of the dam at La Grange, but the low water declivity here adds one and twenty-five hundredths (1.25) feet, more or less, giving a depth of six and fifteen hundredths (6.15) feet, depending, however, on the depth at the La Grange dam and intervening declivity. The State Project

was for a depth of six (6) feet, corresponding to the Illinois and Michigan Canal, and this depth is mentioned as the depth to be had when the dams are removed under Section 23 of the "Act to Create Sanitary Districts," etc., in force July 1, 1889.

*The Expenditures* by the State from the surplus canal revenues in the construction of the dams and locks were: Henry, four hundred thousand dollars (\$400,000); Copperas Creek, three hundred and forty-seven thousand, seven hundred forty-seven dollars and fifty-one cents (\$347,747.51); total, seven hundred and forty-seven thousand, seven hundred and forty-seven dollars and fifty-one cents (\$747,747.51). In addition, the United States constructed the foundation of the Copperas Creek lock at a cost of sixty-two thousand( three hundred and fifty-eight dollars and ninety cents (\$62,358.90), and dredged the bars in the pool above and some auxiliary work, at a cost of ninety-five thousand, seventy-four dollars and twenty-nine cents (\$95,074.29), more or less. Congress, March 2, 1907, appropriated fifty thousand dollars (\$50,000) for channel improvement above Copperas Creek, of which seven thousand, three hundred and ninety-eight dollars and forty-three cents (\$7,398.43) was still available June 13, 1913. The State expended for operation and maintenance of the dams and locks prior to 1890 the sum of seventy thousand, eight hundred and seventy-one dollars and eighty-five cents (\$70,871.85). (See appendix for detail.)

**16.** *The Shrinkage of the River Bed* is shown by the profiles of different surveys and by comparative estimates of the bank-full capacity.



*The Profiles of Record* between Utica and Havana are those of John B. Preston, 1857-8, the Wilson profile of 1867, and the profile of the Ernst Board from soundings made in 1903 (Survey of 1902-4). The Preston profile (printed in the preliminary report of General J. H. Wilson in 1867) shows correctly the general character of the river, but a careful study thereof indicates that the soundings are too infrequent and not sufficiently located for close comparison. The profile from the Federal survey of 1867, both by the report and by critical examination, appears to show the river bed accurately in the natural condition and before considerable change had occurred through the inhabitation of the basin. The profile of 1903, corrected for thalweg, shows the river bed thirty-six (36) years later and thirty-two (32) years after the closing of the Henry dam and twenty-seven (27) years after the closing of the Copperas Creek dam. These two profiles are platted to the same scale and plane of reference and are shown on the exhibit hereto attached, together with a number of flow lines referred to later.

*A Material Filling of the River Bed* is shown in the thirty-six (36) year interval, 1867-1903, and is depicted in black on the exhibit. It appears that deep filling has occurred in pools and broad waters and that the same is relatively small or absent on shoals and narrow places and that this filling is accentuated near the dams, below the mouth of tributaries and at the head of the Henry pool near Utica, where the Upper Illinois dumps its load. Scour has occurred in localities, particularly between Chillicothe and the head of Lake Peoria, which may be ascribed to ice gorges, which are known to occur in that stretch.

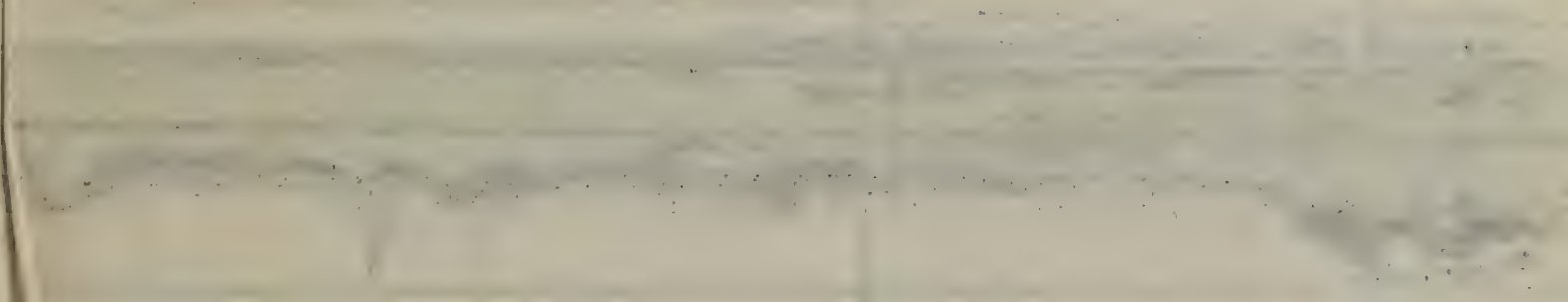
Local filling approaches or is above natural low water and in deep reaches ranges up to ten (10) feet or more. The average fill between Utica and Havana, one hundred nine and nine-tenths (109.9) miles is two and six-tenths (2.6) feet out of the average natural low water depth of eight and seventy-six hundredths (8.76) feet, or thirty per cent (30%) of the depth (See Exhibit) shown on the profile of 1867. The fill is least in the reach of seventeen and one-tenth (17.1) miles between Copperas Creek and Havana, one and seven-tenths (1.7) feet out of nine and two-tenths (9.2) feet, but the La Grange dam was not closed until 1889-90 and its backwater effect on this reach is nominal. The fill is greatest in the broad expanse of Lake Peoria, seventeen and one-tenth (17.1) miles and averages five and six-tenths (5.6) feet out of eleven and seventy-five hundredths (11.75) feet in depth, or forty-eight per cent (48%). Judging by the bottom profile of 1883 and 1899 in Lake Joliet (See Exhibit, topic 4) the filling occurred most largely in the latter half of the period and this is borne out by a study of the bank-full capacity and by local observation to the effect that tributary contributions were impounded in the tributary backwater and did not reach the pools created by the dams for a number of years. (Lakes and Gulf Waterway, 1891.)

*The Bank Full Capacity* taken uniformly at twelve (12) feet above natural low water, is not known for the natural condition of the river prior to the erection of the dams. The following estimates are based on actual measurements of volume and the depth of flow over dams, and are to be taken as an approxi-

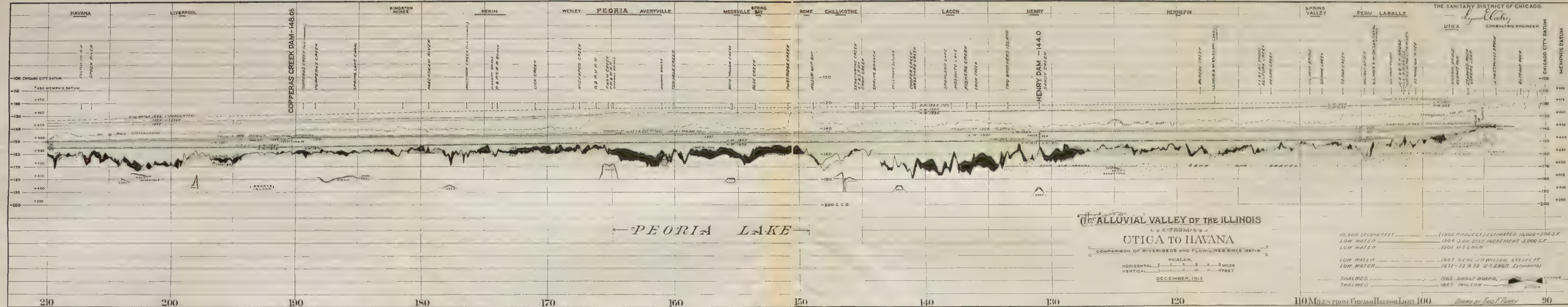


DATE	TIME	LOCATION	WIND DIRECTION	WIND SPEED	WAVE HEIGHT	SEA STATE	TEMPERATURE	MOON	STAR
10/10/54	0800	1000	090	10	2	1	18.5		
10/10/54	0900	1000	090	10	2	1	18.5		
10/10/54	1000	1000	090	10	2	1	18.5		
10/10/54	1100	1000	090	10	2	1	18.5		
10/10/54	1200	1000	090	10	2	1	18.5		
10/10/54	1300	1000	090	10	2	1	18.5		
10/10/54	1400	1000	090	10	2	1	18.5		
10/10/54	1500	1000	090	10	2	1	18.5		
10/10/54	1600	1000	090	10	2	1	18.5		
10/10/54	1700	1000	090	10	2	1	18.5		
10/10/54	1800	1000	090	10	2	1	18.5		
10/10/54	1900	1000	090	10	2	1	18.5		
10/10/54	2000	1000	090	10	2	1	18.5		
10/10/54	2100	1000	090	10	2	1	18.5		
10/10/54	2200	1000	090	10	2	1	18.5		
10/10/54	2300	1000	090	10	2	1	18.5		

CHALLENGER CUBEX DATA - 1954



10/10/54





mation to conditions of steady flow, but extraordinary phasing occurs due to the rising and falling stages, backwater from lower tributaries and overflow conditions, so that the individual measurements may be misleading and any estimate is to be taken with caution.

Locality.	Marshall.	Cooley.	Harmon.	U. S. Geol. Sanitary		
				Woerman. Survey.	District	
	1889	1889-90	1900	1902-4	1904	Recent
La Salle-Peru..s. f.	18,000	20,000	.....	.....	13,000	18,000
Henry ..... “	....	20-22,000	.....	11,000	.....	15,000
Peoria ..... “	....	.....	19,000	15,000	15,400	17,000
Copperas Creek “	....	18-20,000	.....	.....	.....	.....
Havana ..... “	....	.....	.....	21,000	20,000	23,000

The foregoing tabulation is suggestive, rather than indicative. The Havana observations suggest an expanding capacity through the central basin, together with a lower bank height in the vicinity. The Peoria observations of 1900 seem to be excessive in comparison with those of 1902-4. Otherwise, there seems to have been a general decrease in capacity between the time of the observations made ten (10) or eleven (11) years prior to the opening of the Drainage Canal and those made soon after, and again an increase of capacity appears to be shown by later observations, but there has been no recent survey of the river bed. The shrinkage in capacity seems to have been arrested and reversed by the increment of water from Lake Michigan, but the evidence is not conclusive.

*The Shrinkage in Capacity* during the period of thirty-six (36) years between the survey of 1867 and 1902-4 may be inferred from the data shown on the

exhibit together with other hydraulic elements, and is taken at fifteen to twenty per cent (15 to 20%) at the bank-full stage. It would be greater at lower stages, and were the dam removed low water could not go down to its former level. At flood stages well above the banks, the increased height would be nominal, but the flood would be prolonged by reason of the diminished capacity of the channel of drainage. In case of reclamation with nominal overflow of bottoms, there would be an effect at all stages, diminishing with the flood heights, in accordance with hydraulic principles. As the deposits in the river bed have occurred most largely in the pools, rather than in the shallow reaches and on bars, the effect on the ruling depth for navigation does not yet correspond to the depreciation in hydraulic capacity, but a marked change in this respect took place in the interval between the investigation of the undersigned in 1890 and the profile of 1903, as shown by the following statement (Lakes & Gulf Waterway, published 1891, p. 73): "It is probable that when the tributaries have readjusted themselves to the new conditions, the detritus will be carried through to the river unless it is deposited by overflows on the bottoms. The latter result is destructive to the bottoms; the former is to fill the river bed, until ultimately, if a new adjustment be possible, the river will establish an equilibrium on a higher plane with relatively lower banks—destructive alike to the bottoms and to navigation."

*The Federal Report* of Gen'l J. H. Wilson, February 15, 1867, recommended an improvement by dams and locks of the same dimensions as contained in the



bill then pending in the Illinois Legislature (approved and in force February 28) and as later recommended by the Board (Wilson & Gooding) in their report of December 17, 1867 (1868), was originally proposed by John B. Preston in 1858 and contained in the bill before Congress in 1862, with locks of same dimensions, introduced as a war measure. This project was the subject of protest in 1868-9 (Chief of Engineers, 1870) and the United States did not again take up the project until after the report of Capt. J. G. Lydecker in 1879. The following excerpt states the situation. (Lakes and Gulf Waterway 1890, p. 6.) "The plan recommended was the occasion of vigorous dissent by two of General Wilson's assistants, Robt. E. McMath and Col. H. A. Ulffers, and it is said that General Wilson himself became convinced that locks and dams below Utica were in error. The steamboat men and the interests centered at St. Louis were adverse to the plan and have so continued and the late Capt. James B. Eads is reported to have called attention to the mistake of damming an alluvial stream of slight declivity." General Wilson, in a letter to the undersigned (April 25, 1888), states, "I was controlled largely by the consideration that it would not be practicable to secure appropriations for a greater depth, and not by the belief that a greater depth would not be desirable and necessary. \* \* \* The great increase of wealth and population of the country will make the undertaking less costly, relatively, than I estimated twenty (20) years ago and vastly more important."

The improvement of the Illinois River had been

deterred in Congress by doubt regarding the propriety of the lock and dam system. (Member of R. & H. Committee to undersigned in 1888.)

**17.** *The Effect on Stage* of an increment of water from Lake Michigan, in the light of existing data, was carefully considered by the undersigned, prior to the legislation of 1889 and was set forth at length in a report in 1890. (Lakes and Gulf Waterway, etc., 1891.) The data respecting the subject matter are recapitulated as follows:

*The General Assembly of Illinois* in 1861, by a joint resolution, directed a survey of the Illinois River and its canal connection with Lake Michigan for the purpose, among other things, of determining the relative utility and cost “of the different methods proposed or desirable for improving the navigation of the Illinois River by dredging or excavation of the channel and wing dams, or by supplying water from Lake Michigan, through the enlargement and deepening of the Illinois and Michigan Canal, or otherwise \* \* \* and down said canal to a point that will secure a free flowing, ample and never-failing supply of water sufficient for the navigation of the Illinois River at all seasons and times,” etc. This proposition probably goes back to the Preston project of 1858. (Topic 16.) The same proposition was contained in the bill before Congress in 1862 and Thad. Stevens remarked “You will drain the lake and find nothing but dry land.” The Waterway Convention in Chicago, June 2, 1863, urged this project as part of an enlarged water route between the Mississippi River and the Atlantic seaboard. No report under this joint resolution has been found.



*General J. H. Wilson*, by department letter of September 13, 1866, was instructed, among other things, to consider “\* \* \* the solution of the question of an adequate supply of water from Lake Michigan as a reservoir for the canal and river during periods of low water.” The preliminary report of February 15, 1867, in an appendix by Assistant S. T. Abert, discusses the subject and concludes that with an increment of four thousand five hundred and fifty-five (4,555) second-feet, from Lake Michigan and “by the aid of one, or at most two dams (near the mouth), together with a small amount of dredging upon some of the bars, a navigation of six (6) feet depth can be obtained between La Salle and Grafton.” Wilson and Gooding in their report of December 17, 1867 (1868), concluded that the scheme “is impracticable at any reasonable cost,” and base their findings on the cost of the feeding channel across the Chicago Divide. It appears that this channel was not well considered, was wide and shallow rather than deep, and the cost thereby doubled. This matter was fully discussed in the *Lakes and Gulf Waterway*, 1890-1, p. 5.

*S. T. Abert, Civil Assistant*, determines the stage of water corresponding to five thousand, one hundred and eighty-eight (5,188) second-feet at Hennepin, or, four thousand five hundred and fifty-five (4,555) second-feet plus the natural low water volume of six hundred thirty-three (633) second-feet, as referred to the low water of 1866, the same corresponding to prior low waters. The low water of 1866 is fifty-four hundredths (0.54) foot above the low water of 1867 at Peoria, and is taken parallel

thereto. Standard low water of 1871-3-9 corresponds to 1867 at La Salle-Peru, and is five-tenths (0.5) foot lower at Henry and Peoria, so the correction is taken at five-tenths (0.5) foot for La Salle-Peru, eight-tenths (0.8) foot at Hennepin and (1.0) foot from Henry to Havana. The following tabulations, corrected for standard low water, give the Abert record with his interpolations below Hennepin. A column showing experience with steady flow is added for comparison:

Locality.		Dec. 3, 1866	Oct. 14, 1866	Experience
		Simultaneous Observations.	Increment 4,555 s. f.	1904, Increment 5,000 s. f.
	Miles.	Ft.	Ft.	Ft.
Utica .....	0.0	...	...	...
La Salle-Peru .....	6.5	9.8	8.9	7.2
Hennepin .....	22.4	...	8.2	7.2
(Henry Dam) .....	33.5	...	...	7.3
Lacon .....	39.5	7 to 6.4	6 to 5.4	7.4
(Chillicothe) .....	47.9	...	...	6.4
Peoria .....	67.3	7.0	6.0	6.4
Copperas Creek Dam.	92.8	...	...	6.6
Havana .....	109.9	...	...	6.1
Beardstown .....	141.3	4.8	3.8	4.7

The report shows a phasing condition in the river and no allowance for time intervals, and notes further that a rising river gives a higher stage at Lacon than at Peoria. Only one point, La Salle-Peru, is common to the observations of December 3, and October 14, and the difference nine-tenths (0.9) foot is used for interpolating the plane below Hennepin, corresponding to five thousand one hundred and eighty-eight (5,188) second-feet at Hennepin and this made his interpolated plane too low. The third column represents steady flow (hereafter discussed) and is added for comparison and illustrates the discrepancies due to the head water rise and phasing



conditions which gives up-stream stages too great and down-stream stages too small, nevertheless (p. 22), Mr. Abert concludes that a navigable depth of seven (7) feet will obtain from La Salle to Spring Lake (Copperas Creek dam) and five (5) feet thence to Beardstown. (H. R. 16, 40th Cong., 1st Sess.)

*Lyman E. Cooley*, then Chief Assistant of the Drainage and Water Supply Commission, in testimony (printed) before the special joint committee of the General Assembly, April 7, 1887, reviewed the data of Abert and with later data made a preliminary estimate of the probable stage of water due to an increment of ten thousand (10,000) second-feet from Lake Michigan, as follows: La Salle-Peru, twelve (12) feet above natural low water; Henry, nine to ten (9 to 10) feet; Peoria, seven to eight (7 to 8) feet; Beardstown five (5) to six (6) feet; and approaching the mouth, five (5) feet. In "The Lakes and Gulf Waterway" (published January, 1888) by the Citizens Association of Chicago on behalf of the Executive Committee of the Peoria Convention of October 11-12, 1887, for the purpose of enlisting the co-operation of the National Government in the Illinois Waterway, the history and physical conditions are reviewed, projects compared and the feasibility is developed of producing a navigable depth of fourteen (14) feet through the valley, by the aid of ten thousand (10,000) second-feet from Lake Michigan. "Roughly estimated, about twenty-five million (25,000,000) yards of material must be moved to furnish a channel through the bars below La Salle, three hundred (300) feet wide and for fourteen (14) feet of water, costing, say, five million dollars (\$5,000,000)." (P. 30.)

*Capt. W. L. Marshall*, under Act of Congress of August 11, 1888, passed in response to representations before mentioned, reported, February 28, 1890. A project of a depth of fourteen (14) feet was called for, but this is most strenuously opposed in this report. Taking the low water volume of the Lower Illinois uniformly at one thousand (1,000) second-feet, the report (page 27) estimated the effect above standard low water of an increment of five thousand (5,000) second-feet and of ten thousand (10,000) second-feet, at three points:

Location.	5,000 s. f.	10,000 s. f.
La Salle .....	7.2'	9.9'
La Grange .....	3.0'	5.5'
Kampsville .....	2.3'	4.5'

*Lyman E. Cooley* in 1888-9, then Consulting Engineer to the State Board of Health, and the Joint Committee of the General Assembly (including the Mayor of Chicago), which framed the Sanitary District Act, collected the available data for use in the legislation of 1889. In 1890, as Chief Engineer of the Sanitary District, the available data were digested in a number of tables, published in 1891. (P. 65-9, Lakes and Gulf Waterway as related to the Sanitary problem.) The natural low water volume was taken at six hundred (600) second-feet from La Salle to Copperas Creek, and at one thousand two hundred (1,200) second-feet below Crooked Creek. The stages above natural low water for increment of two thousand (2,000) second-feet, five thousand (5,000) second-feet and ten thousand (10,000) second-feet were estimated as follows:



Location	Distance. Miles.	2,000 s. f.	5,000 s. f.	10,000 s. f.
Utica .....	0.0	3.6'	5.6'	8.0'
Henry .....	33.5	3.4'	5.3'	7.5'
Peoria .....	63.7	3.1'	5.0'	6.8'
Copperas Creek .....	92.8	3.5'	5.1'	7.1'
Havana .....	109.9	(3.8)	(4.6)	(6.4)

“These hights may be assumed to represent the stages to be relied upon for navigation, above the Sangamon, though it will be safe to add a half ( $\frac{1}{2}$ ) foot for the purpose of other comparison.” Further tabulations show that an increment of five thousand (5,000) second-feet will give a depth of seven (7) feet in the natural river and that an increment of two thousand (2,000) second-feet will give a depth of seven (7) feet with limited dredging. The result in either case exceeds the depth produced by the dams. A fourteen (14) foot channel three hundred (300) feet wide with water surface three to four (3 to 4) feet above the standard low water surface at La Salle is roughly estimated at sixty million (60,000,000) yards and a cost of six million dollars (\$6,000,000). The foregoing estimates of stages were extremely conservative, but this adds to their significance in contemporary legislation, in the organization of the Sanitary District of Chicago and in the deep water project.

*The Ernst Board* made elaborate surveys and investigations (1902-4) and developed the project for fourteen (14) feet of water between Lockport and Grafton. Its report (Aug. 26, 1905—H. R. 263, 59th Cong., 1st Sess.) contains an extensive collection of data and among other things said (p. 18), “The

additional flow provided by the Chicago Drainage Canal is now four thousand two hundred (4,200) second-feet. It will allow the removal of the present locks and dams, and will make practicable the maintenance of an open channel considerably deeper than the seven (7) feet now provided by these structures. The increase to ten thousand five hundred (10,500) second-feet makes practicable a still greater open channel." And (p. 11) "In a future not remote, larger volumes of water may be needed for sanitary purposes, and channels deeper than fourteen (14) feet will then become practicable in the open alluvial section of the Illinois River." The project for a navigable depth of fourteen (14) feet is based on a low water volume of five hundred (500) second-feet for the upper division and one thousand (1,000) second-feet for the lower division and an increment of ten thousand (10,000) second-feet from Lake Michigan. The estimate is for a channel two hundred (200) feet wide on the bottom with a yardage of twenty-seven million eight hundred sixty-seven thousand sixty (27,867,060) cubic yards and at a cost, including other items, of eight million one hundred eighty-seven thousand six hundred and eighty-two dollars (\$8,187,682). The excavation between La Salle-Peru and Peoria is nominal except in broad waters, and without material effect on stage and declivity. Below Peoria, and also below the mouth of the Mackinaw, the improved channel will lessen the declivity and lower the stages above Peoria; again, heavy excavation between Spoon River and the Sangamon will lower the stages above Havana.



The estimated stage above standard low water from Utica to Havana is taken from the profile as follows:

Location.	Distance.	Stage.
Utica .....	0.0 miles	11.0'
La Salle-Peru .....	6.5 "	10.2'
Hennepin Canal .....	19.4 "	9.8'
Henry .....	33.5 "	9.5'
Chillicothe .....	50.2 "	8.4'
Peoria .....	67.3 "	8.4'
Copperas Creek .....	92.8 "	7.8'
Havana .....	109.9 "	5.8'

The discharge measurements are not determinative, but indicate higher stages by six-tenths (0.6) foot at La Salle-Peru; two (2.0) feet at Henry and Peoria; and two and three-tenths (2.3) feet at Havana. The latest rating curve indicates higher stages by one and one-tenth (1.1) feet at La Salle-Peru; one and five-tenths (1.5) feet at Henry; two and two-tenths (2.2) feet at Peoria and two and seven-tenths (2.7) feet at Havana.

*The Experience with Steady Flow* is indicated by the low water profile of 1901, corresponding to an increment of three thousand four hundred (3,400) second-feet at Lockport and the low water of 1904, corresponding to an increment of five thousand (5,000) second-feet (approx.), assuming that the stage at the head of the pools is not affected for these volumes by back water from the dams. This may not be true for 1901 at La Salle-Peru, as profile indicates a flash board on the Henry dam, nor at Peoria and Chillicothe, and it may not be quite true for 1904 at Peoria and Chillicothe. The stages above standard low water are as follows:

Locality.	Distance Miles.	1901 3,400 s. f.	1904 5,000 s. f.
Utica .....	0.0	...	...
La Salle-Peru .....	6.5	5.9' (5.3)'	7.2'
(Hennepin) .....	19.4	(5.3)'	(7.2)'
Henry (below dam) .....	33.5	5.3' interpolated	7.3'
(Chillicothe) .....	50.2	5.3' (4.7)'	6.4'
Peoria .....	67.3	5.4' (4.6)'	6.4'
Copperas Creek (below dam) .....	92.8	4.4'	6.6'
Havana .....	109.9	4.3'	6.1'

The fall over the two dams in 1904 was about one (1) foot, so that the elevations were not materially affected between Peoria and Henry and La Salle-Peru; nor would the La Grange dam materially affect the reach between Copperas Creek and Havana. The low water of 1901 had a fall of two and one-half ( $2\frac{1}{2}$ ) feet at Copperas Creek and three (3) feet at Henry, due probably to flash boards, and the elevations at La Salle-Peru and at Peoria and Chillicothe probably exceed those which would prevail in the absence of the dams, but elevations between Copperas Creek and Havana may be taken as true. These results indicate that an increment of four thousand one hundred sixty-seven (4,167) second-feet (250,000 minute feet), which is the volume conceded by Federal permits, would give five and five-tenths (5.5) feet to six and twenty-five hundredths (6.25) feet above standard low water from La Salle-Peru to Copperas Creek, and this gives the six (6) feet for which the two state dams were designed and constructed, except where the river bed may have filled within half ( $\frac{1}{2}$ ) a foot of natural low water. The fill in the river bed nowhere reached the stand-



ard low water line between La Salle-Peru and Copperas Creek up to the soundings of 1903 (survey of 1902-4), but there has been no general survey since to indicate the present conditions. The low water profile of 1904, corrected for back water effect of the Copperas Creek dam, below Peoria and for the Henry dam above Henry, may be taken as an approximate determination of the stage due to an increment of five thousand (5,000) second-feet from Lake Michigan, or five thousand five hundred (5,500) second-feet in the river. The actual volume in the river may be slightly in excess.

*No Satisfactory Comparison*, in detail, can be made between the actual stages due to steady flow in 1904 and the estimate based on data prior to 1890 from unsteady flow and phasing conditions. A careful study shows that the measured volumes are extremely erratic in respect to stage, and that the rating curves deduced therefrom are not reliably indicative. The volume at La Salle on a rising stage greatly exceeds that at Peoria, due to the regulating effect of the broad expanse between Henry and Peoria, which establishes a temporary regimen and enables approximate comparisons for volume and stage. The results obtained by Abert have all the infirmities due to variable flow and also to errors in treatment, they are qualitative rather than quantitative, but they are valuable and sufficiently indicative. The estimates by Cooley are more consistent in relation to steady flow and were admittedly conservative, but are far more conservative than supposed. It may be, that part of the discrepancy between the results of the earlier observations and the

experience of 1904 is due to depreciation of the river bed, as already set forth in Topic 16, but the measured volumes in recent years are not clearly indicative and no general survey of the river bed has been made since 1903.

*The Increment of 10,000 Second-Feet* in its effect on stage is not determined by experience. The project profile of the Ernst Board (Survey, 1902-4) has been carefully worked up from theoretical considerations in part, and involves no radical changes in the river bed between La Salle and Copperas Creek and, subject to qualifications already made, it may be taken as the best criterion prior to actual experience. The Cooley estimates of 1888-90 are conservative in comparison, but the difference lessens down stream, which may be due in part to the improved channel—particularly below Havana. The measured volumes and the rating curves generally indicate a higher level, but these evidences are elusive. Again, it is probable that shrinkage in the capacity of the river bed will account for some of the anomalies.

**18.** *Legislation for the Removal of the State Dams* at Henry and Copperas Creek was based on the estimated effect of an increment of five thousand (5,000) second-feet from Lake Michigan as set forth in the preceding topic (17). This legislation is comprehended in—

(a) “An Act in Reference to the Improvement of the Illinois and Desplaines Rivers, and to Repeal an Act.....,” approved June 4, 1889, in force July 1, 1889.

(b) “An Act to Create Sanitary Districts and to remove obstructions in the Desplaines and Illinois



Rivers.” Approved May 29, 1889, in force July 1, 1889.

(c) Joint Resolution—H. R., May 27, 1889, and S. May 28, 1889.

(d) Joint Resolution—S., May 27, 1897, and H. R., May . . . ., 1897.

*The State Works* at Henry and Copperas Creek were ceded to the United States by the Act of 1887, on condition that a through waterway of a depth of seven (7) feet should be produced. The Act of 1889, above cited (a), known as the “Little Waterway Bill,” repeals the cession and makes a new cession. (Sec. 2), “on condition that the dams shall be removed whenever the depth now available for navigation can be secured and maintained by channel improvement without the aid of said dams; provided, that said depth shall be assured upon removal of said dams, or that such removal shall not materially impair navigation.” Section 4 “bases this Act of cession upon the condition that the plan of improving the Illinois River below La Salle by slack water, maintained by dams and locks, be changed to a plan of improvement by means of an open channel in conjunction with a water supply from Lake Michigan.” Section 3 provides that in case the United States does not accept this cession within four years, “The Canal Commissioners of the State of Illinois be authorized and instructed to remove the dams at Henry and Copperas Creek.”

The foregoing Act was drawn by the undersigned in response to a demand by the valley people for the removal of these dams and a change to an open chan-

nel policy, and the bill was introduced in the House while the Sanitary District Act was on its passage.

*The Act to Create Sanitary Districts*, while pending in the Senate, was amended by Senator Leeper, of Cass, by inserting in Section 19 in respect to damages: "And in case judgment is rendered against such district for damages, the plaintiff shall recover his reasonable attorneys' fees, to be taxed as costs of suit;" etc. With a view of mitigating the severity of the damage section, the undersigned suggested the following addition to Section 23: "The District constructing a channel to carry water from Lake Michigan of any amount authorized by this Act, may correct, modify and remove obstructions in the Desplaines and Illinois Rivers wherever it shall be necessary so to do to prevent overflow or damage along said river." The addition of this clause led Senator Shumway, of Christian, to amend the title of the bill by adding the following: "And to Remove Obstructions in the Desplaines and Illinois Rivers." Senator Newell, of Woodford, later Assistant Attorney General in the Altgeld administration, added to Section 23, as amended, the essence of the "Little Waterway Bill" above referred to (a) as follows: "And shall remove the dams at Henry and Copperas Creek in the Illinois River, before any water shall be turned into the said channel;" and also, "and the Canal Commissioners, if they shall find at any time that an additional supply of water has been added to either of the said rivers, by any drainage district or districts, to maintain a depth of not less than six feet from any dam owned by the state, to and into the first lock of the Illinois and Michigan Canal



at La Salle without the aid of any such dam or dams, at low water, then it shall be the duty of said canal commissioners to cause such dam or dams to be removed." It will be noticed that the latter part of this clause refers correctly to the depth of six feet for which the State works were designed and constructed (Topic 16). Senator Newell urged the first part of this Amendment in the belief that the "Little Waterway Bill" would not reach the Senate. The second part of the Amendment was urged by reason of the fact that a depth of six (6) feet could be produced by an increment of two thousand (2,000) second-feet (Topic 17), which was then contemplated by means of pumping works at Chicago as a measure of temporary relief pending the execution of the project for permanent relief. Such temporary provision was suggested by the State Board of Health and under advisement by the Mayor of Chicago, John A. Roche, and his Consulting Engineer, the undersigned. (See Lakes and Gulf Waterway, 1890-p. 65 *et seq.*)

*The Joint Resolution of 1889* declares a deep waterway policy for the State and asks Federal co-operation. A depth of twenty-two (22) feet across the Chicago Divide and fourteen (14) feet thence to Utica, so designed as to permit future increase in capacity, is called for and the United States is requested to stop work upon the dams at La Grange and Kampsville, and to apply its funds "in such manner as to develop progressively all the depth practicable by the aid of a large water supply from Lake Michigan at Chicago."

The Joint Resolution of 1897 reiterates the

Joint Resolution of 1889, recites the intervening facts and requests the United States to remove the dams at La Grange and Kampsville when the increment of water is established and the State dams removed at Henry and Copperas Creek.

*An Open River* without obstructing dams and locks, to be improved by dredging and the aid of a water supply from Lake Michigan, is the policy of the State and the same is clearly set forth and provided for by the two Acts and the two Joint Resolutions already cited and in all subsequent legislation. Such legislation, taken as a whole, together with the Constitutional Amendment of 1907-8, clearly contemplate a deep waterway to be produced through the co-operation of local agencies and the State and Nation.

**19.** *The Removal of the State Dams* at Henry and Copperas Creek was considered by the Board of Trustees of the Sanitary District, June 14, 1899 (p. 5877 proceedings), and the subject matter referred to the Joint Committee on Federal Relations and Engineering. This committee reported October 18, 1899, (p. 6085 proceedings) and recommended that a special committee of three (3) be appointed by the President of the Board with full powers to remove the dams and on October 25, 1899 (p. 6087 proceedings), the President reported the appointment of Messrs. Jones, Carter and Braden. Identical bills of complaint to the Circuit Court on behalf of Fulton County and on behalf of the Canal Commissioners were heard *ex parte* by Judge Grey and a temporary injunction granted November 13, 1899, and the Sanitary District notified thereof on the same day, to



which a general demurrer was filed November 18. The complaint alleges among other things that the special committee of the Sanitary District met on November 10, and determined to blow the dams out of the river by means of high explosives, that the dams would in no way injure the defendant by increasing the stage of water or the amount of overflow, that the increment of water from Lake Michigan would produce no greater depth on the dams than now produced by the "splash boards" and that the removal of the dams would restore prior conditions and impair or destroy the improved navigation. The Court (W. S. Thompson) sustained the demurrer November 28, 1899. An Amended Bill of Complaint, December 14, 1899, was filed and demurred to and the Court on the same day sustained the demurrer, dissolved the injunction and dismissed the bills.

*The Appeal to the Supreme Court* was decided February 19, 1900 (Opinion by Phillips, Vol. 184 Ills. P. 597) adversely to the Sanitary District, the decision of the lower court reversed and the case remanded for trial on its merits. The court held that the clause in Sec. 23 of the Sanitary District Act was not mandatory, but permissive, and that the dams could not be removed until an equivalent navigable depth is available without the aid of the dams. The Sanitary District petitioned for a rehearing at the February term and recited at length the change in State policy and the legislative intent as shown by other legislation, both contemporary and later, herein referred to in preceeding topic (No. 18) but the petition was denied April 17, 1900. (Vol. 184, Ill., P. 597.)

The trial of the case on its merits has not been taken up in the Circuit Court of Fulton County.

*No Actual Data* respecting the effect of the increment of water on the stage in the Illinois River and the equivalents thereof to the depth produced by the State dams, other than inferences from statutes and resolutions, was presented by the Sanitary District, but the complainant based his case on positive allegation and denials respecting the competence of the increment of water to produce results that would justify the removal of the dams. In the legislation of 1889, the General Assembly had before it the available data respecting the effect of an increment of water in the absence of the dams, and this led the valley people to demand the removal of the dams, and the change in policy to an open channel, and such program was deemed just and proper by the General Assembly and has been adhered to in all subsequent legislation.

The State not only defined its policy and provided for its own, but went further and did what it could to induce the United States to conform its policy to the changed conditions and necessities of the situation.

The data showing the effect of the increment of water has already been set forth in Topic 17, and the effect of the dams in Topics 15 and 16.

*The Association of Drainage and Levee Districts* of Illinois at the Springfield meeting of its Executive Committee, March 8, 1912, formulated an address to the Secretary of War praying for a refusal to the Sanitary District of its petition for a greater volume of water until the dams in the Illinois River had



been removed. Some conferences had taken place at various times between the Sanitary District Trustees and the Canal Commissioners and this action quickened negotiations and it was understood that an agreement had been reached respecting the removal of the State dams.

*The Lakes to the Gulf Deep Waterway Association* took up the question as a part of its program of deep water between the Lakes and the Gulf and under its auspices the matter was presented at a hearing before the Senate Committee on Commerce, April 16, 1912. The following organizations were represented: The Lakes to the Gulf Deep Waterway Association by its President, Chairman of Executive Committee and its Consulting Engineer. The Sanitary District by the Chairman of its committee on Federal Relations, its Attorney and its Consulting Engineer. The City of Chicago by its Commissioner of Public Works. The Canal Commissioners by their Attorney. The River and Lakes Commission of Illinois by its Engineer member. The Association of Drainage and Levee Districts of Illinois by its past President. The Illinois Valley Association by its Secretary and Special Delegate and the National Drainage Congress by a special delegate.

*A Paragraph for a River and Harbor Bill* had been agreed to and was presented as follows:

“The sum of \$1,000,000 appropriated by the rivers and harbors act, approved June 25, 1910, for the development of a deep waterway in the Des Plaines and Illinois Rivers under certain conditions therein mentioned is hereby made available for the improvement of the alluvial division of the Illinois River between its mouth and Utica without the aid of any dam and



by means of any water supply established through the Chicago Drainage Canal and dredging a channel in said river in conjunction therewith; PROVIDED, That the Secretary of War shall issue his permit to the sanitary district of Chicago or other responsible agency of the State of Illinois for the removal of the Federal dams at Kampsville and La Grange whenever the State dams at Copperas Creek and Henry shall have been removed, the removal of all of said dams to be under the direction of and to the satisfaction of the Secretary of War; AND PROVIDED FURTHER, That upon the removal of said dams a navigable depth of 6 feet at low water over the portion of the river controlled by such dams shall be assured to the satisfaction of the Secretary of War, and such depth may be produced by the increment of water added to said river or by dredging in connection with such increment of water, and such part of the money herein made available as may be necessary shall first be applied to the development of such preliminary depth in order to expedite the removal of said dams: AND IT IS FURTHER PROVIDED, That the balance of the funds herein made available shall be first applied to the production of a navigable channel of a provisional depth of eight feet upon such plan of progressive development as will be best adapted to further increase of depth to fourteen feet or more, as may be hereafter determined and money appropriated therefor by Congress."

The subject-matter was heard at great length and it developed that neither the State nor the Sanitary District had removed the State dams at Henry and Copperas Creek under the legislation of 1889, and that the case remanded by the Supreme Court to the Circuit Court of Fulton County in February, 1900, had not been tried out on its merits. In view of these circumstances the Committee concluded that



action respecting the removal of the Federal dams should be deferred.

*No Actual Agreement* had been closed between the Sanitary District and the Canal Commissioners, as had been assumed when the hearing was asked for and the several parties invited to participate, and no actual agreement has since been reached. It is understood in a general way that the Canal Commissioners will join the Sanitary District Trustees in a consent decree, subject to certain stipulations respecting any deficiency in the depth and restriction in water supply which may exist after the dams are removed.

*The War Department* attitude seems to be, that the State dams may be within the purview of Section 10 of the Act of Congress of March 3, 1899, and require its consent to the removal of the dams, but that no objection will be made as the flow of four thousand one hundred and sixty-seven (4,167) second-feet may be considered as established. The removal of the Federal dams will require the authority of Congress and under such authority the Department probably will make no objections.

**20.** *A Summary of the Salient Facts* respecting the Upper division of the Lower Illinois Valley is set forth as follows:

(a) The Upper Division includes about one-third ( $\frac{1}{3}$ ) the area of the valley, one-half ( $\frac{1}{2}$ ) the water, one-sixth ( $\frac{1}{6}$ ) of the lands under reclamation, and two-thirds ( $\frac{2}{3}$ ) the amount of damage claims from overflow.

(b) The Henry dam and lock was authorized in 1867 and opened in 1871, and the dam and lock at

Copperas Creek was authorized in 1873 and opened in 1877. The locks are three hundred fifty (350) feet in length between quoins and seventy-five (75) feet in width, with six (6) feet on the mitre sills at low water, or the same as the depth of the Illinois and Michigan Canal. The works were built from surplus canal revenue at a cost of seven hundred forty-seven thousand, seven hundred forty-seven dollars and fifty-one cents (\$747,747.51). The United States constructed the foundation for the Copperas Creek lock at a cost of sixty-two thousand three hundred fifty-eight dollars and ninety cents (\$62,358.90) and dredged the bars in the pool above at a cost of \$95,074.29. (Appx.)

(c) The fill in the river bed in the interval of thirty-six (36) years between 1867 and 1903, has been thirty per cent (30%) of the depth below standard low water of 1871-3-9, and the bank full capacity has been diminished by some fifteen to twenty per cent (15% to 20%). This fill is greatest in deep and in broad waters and least in narrow and shallow reaches or the ruling points for navigation. The comparative profiles in Lake Joliet indicate the major fill in the last half of the period, and the study of 1888-90 respecting conditions in the alluvial valley are in accord. Reclamation and tillage have increased the burden of detritus in the stream and the dams have played a part in arresting the same.

(d) The improvement of navigation in the Lower Illinois by an increment of water from Lake Michigan is probably due to the Preston surveys of 1857-8 and found expression in the Joint Resolution of the General Assembly in 1861. Federal examination in



1866-7 determined that an increment of four thousand five hundred fifty-five (4,555) second-feet will produce a navigable depth of seven (7) feet over the bars down to Copperas Creek and five (5) feet thence to Beardstown, but, the project is rejected by reason of an awkward mistake in the plan and estimate for the feeding channel across the Chicago Divide. These and later data, set forth in the report of 1890, led the General Assembly to revert to the original project, on a deep water basis in conjunction with the large water supply authorized for sanitary purposes at Chicago.

(e) The State policy respecting a deep waterway with an open channel below Utica improved by an increment of water and dredging, is set forth in the legislation of 1889. The Joint Resolution recites conditions and policy and asks Federal co-operation and this is reiterated in the Joint Resolution of 1897. The "Little Waterway Bill" provides for the removal of the dams at Henry and Copperas Creek when an equivalent depth of water is assured. The Sanitary District Act (Section 23) is mandatory respecting the removal of the State works upon the accession of the preliminary flow of five thousand (5,000) second-feet required by law, through the Main Channel of the Sanitary District.

(f) The experience with such preliminary flow of five thousand (5,000) second-feet is shown by the low water profile of 1904 corrected for back water upstream from the dams. The stage everywhere is more than six (6) feet above standard low water and exceeds the estimates underlying legislation.

The stage due to an increment of four thousand one hundred sixty-seven (4,167) second-feet, the volume conceded by Federal permit, is inferred from the experience profiles, and a depth of six feet reaches about one-half ( $\frac{1}{2}$ ) foot below standard low water in the lower part of the division, or is still about one (1) foot above original bottom at ruling points for navigation.

The Ernst Board (1905) states that such volume makes practicable a depth considerably greater than that produced by the dams.

(g) An increment of ten thousand (10,000) second-feet is the minimum legal capacity of the feeding channel at Chicago, and the Ernst Board (1905) projects a profile for a navigable depth of fourteen (14) feet. Such profile, with due allowance for channel improvement below Peoria, Mackinaw River and Spoon River, may be taken provisionally pending experience determination. The stage indicated is everywhere higher than the early estimates and the evidence from rating curves suggest that this profile is conservative.

(h) An increment of fifteen thousand (15,000) second-feet or more is represented by the joint capacity of the Main Channel of the Sanitary District and the Illinois and Michigan Canal. The report of the Internal Improvement Commission of Illinois for 1907 indicates that such increment will make practicable twenty-four (24) feet to Peoria and eighteen to twenty (18 to 20) feet below. The present study indicates that such depths can be more easily obtained than



heretofore supposed, or that greater depths may be had below Peoria.

(i) The dams can form no part of a deep water project and must be removed as a condition precedent. The fall over the State dams is only one (1) foot for an increment of five thousand (5,000) second-feet at low water and such fall becomes immaterial at high stages within the banks. The stages due to the increments heretofore prevailing have been nearly the equivalent of the average stage in the pools due to the dams. The dams mask largely the effect of an increment of water until the equivalent stage is reached, after which their relative influence lessens with the stages due to increasing increments. Aside from their direct effect on the capacity of channel and their influence in depreciating the river bed, the dams have been more potent in causing overflow than increments of water under an equivalent stage. The removal of the dams, and the dredging of the stream becomes important to the Sanitary District for the larger increments with higher stages. The dams contribute to the filling of the river bed, even where deeply submerged, much as ground-sills raise the deep places and are used for such purposes in river improvement.

(j) The Court held in February, 1900, that the mandatory provision of the law is permissive and that the dams should not be removed until an equivalent navigation obtains and remanded the case for trial on its merits. The facts which were before the General Assembly that made the law were not before the Court that construed it and the trial on

the merits of the case has not been had. At a hearing in Washington, April 16, 1912, the Senate Committee on Commerce would not entertain the proposition to remove the Federal dams and apply a conditional appropriation of one million dollars (\$1,000,000) for works on the Upper Illinois to dredging on the Lower Illinois, until the State had shown its good faith in the deep water project by actually removing the dams at Henry and Copperas Creek.



**D—Lower Division of the Lower Illinois.  
Havana to Grafton.**

**21.** *The Lower Division of the Lower Illinois* extends from Havana to Grafton, a distance of one hundred nineteen and seven-tenths (119.7) miles, although the actual mouth of the Illinois is two and one-tenth (2.1) miles above Grafton. The natural low water declivity is taken at nineteen and eight-tenths (19.8) feet, or about two (2) inches per mile. The elevation at Grafton being taken at one hundred seventy-five (175) feet below Chicago datum (1.08 feet on gauge) and at the level assumed by the Mississippi River Commission (Report of Ernst Board 1905). The low water declivity below Hardin, twenty-one (21) miles above Grafton, varies greatly and depends on the low water stage in the Mississippi River which usually differs in relative value. The zero of the gauge at Grafton is one hundred seventy-six and eight one-hundredths (176.08) feet below Chicago datum and some characteristic *low water* readings are as follows:

Date.	Gauge Readings	Authority.
Extreme low water.....	0.00	Durham.
Mississippi River Commission.....	1.08	Report of Ernst Board, 1905.
	—0.32	Lakes and Gulf Waterway, 1891 (Cooley).
Wilson, 1867 .....	—0.74	Ward.
October, 1879 .....	1.80	Woermann & Durham.
1891 .....	0.40	Durham.
1894 .....	0.80	Woermann & Durham.
1901 .....	1.40	Woermann Profile.
September and October, 1901.....	2.60	Durham.
Navigation season, 1910.....	2.60	Durham.
Navigation season, 1911.....	2.60	Durham.

The three lowest waters in the fourteen years since the opening of the Drainage Canal (January, 1900) occurred in 1901, 1910 and 1911 and are uniformly two and six-tenths (2.6) feet on the Grafton gauge. The low water improvement plane for the Mississippi River has been amended accordingly and corrected for some twenty-five (25) miles upstream, thus raising the former improvement plane (1864 and 1894) by one and eight-tenths (1.8) feet.

*The Natural Low Water Volume* has been taken at both one thousand two hundred (1,200) and one thousand (1,000) second-feet in official projects and probably lower volumes have occurred. The survey of 1879 measured one thousand five hundred and sixty-six (1,566) second-feet, or one thousand three hundred and five (1,305) second-feet after deducting canal water from Chicago.

*The Average Run-Off* has been taken at seven-tenths (0.7) second-foot per square mile of watershed which would give nineteen thousand five hundred and forty (19,540) second-feet at the mouth (27,914 square miles).

*The Flood Volume* of 1904 was one hundred seventeen thousand (117,000) second-feet as measured at Pearl, forty-three (43) miles above Grafton.

*The Bank-Full Capacity* of the natural river bed prior to the erection of the dams at La Grange and Kampsville was estimated from measurements at thirty thousand (30,000) second-feet at La Grange, increasing to forty thousand (40,000) second-feet at Kampsville.

*The Area* under the flood of 1844 has been estimated as follows (See T. 10):



Description.	Acres.
Lands between 1844 and 1904.....	45,462
Lands under 1904 .....	189,632
Ponds, sloughs, etc.....	28,476
River bed .....	12,502
Total (431.4 sq. mi.).....	276,072

*Reclamation Work* developed, or now in progress, is as follows:

Havana to La Grange, 18 Districts, 90,885 Acres:

County.	Name of District.	Acres.	County Acres.
Fulton .....	Lacey .....	6,100	6,100
Mason .....	Quiver River .....	1,600	29,600
" .....	Lynchburg & Sangamon bottoms.....	28,000	.....
Cass .....	Meredosia .....	1,500	25,485
" .....	Penckey Pond .....	1,200	.....
" .....	Clear Creek .....	3,000	.....
" .....	Valley District .....	3,200	.....
" .....	So. Beardstown .....	8,185	.....
" .....	Hager Glen .....	4,000	.....
" .....	Lost Creek .....	1,200	.....
" .....	Clear Lake Special.....	3,200	.....
Mason and Cass..	Mason and Cass, River District..	10,000	10,000
Cass and Morgan..	Mud Creek .....	3,000	3,000
Schuyler .....	Big Lake .....	3,200	15,900
" .....	Private District .....	800	.....
" .....	Coal Creek .....	6,700	.....
" .....	Crane Creek .....	5,200	.....
Brown .....	Kerrs .....	800	800

La Grange to Mouth, 13 Districts, 98,000 Acres:

Cass and Morgan..	Meredosia .....	4,000	6,000
	Private District .....	2,000	.....
Brown and Pike..	Magee .....	12,000	12,000
Scott and Greene..	Hillview .....	12,400	12,400
Morgan .....	Willow Creek .....	1,700	3,700
" .....	Coon River .....	2,000	.....
Scott .....	Scott .....	9,500	21,900
" .....	Naples .....	400	.....
" .....	Big Swan .....	12,000	.....
Greene .....	Hartwell .....	12,000	31,000
" .....	Keach .....	10,000	.....
" .....	Eldred .....	9,000	.....
Jersey .....	Nutwood .....	11,000	11,000

Havana to Mouth, 31 Districts, 188,885 acres (295 square miles).

*Damage Claims* against the Sanitary District, under adjudication, are as follows:

Havana to La Grange.						
Counties.	No.	Permanent.	No.	Temporary.	No.	Total.
Macon .....	2	\$ 33,330	17	\$ 195,150	19	\$ 228,480
Schuyler .....	..	.....	25	251,150	25	.....
Cass .....	..	.....	62	623,050	62	.....
Brown .....	..	.....	4	49,000	4	1,023,200
Totals.....	2	\$ 33,330	108	\$1,118,350	110	\$1,151,680
La Grange to Mouth.						
Scott .....	2	105,000	..	.....	..	.....
Pike .....	..	.....	1	10,000	..	.....
Greene .....	3	364,000	..	.....	..	.....
	5	469,000	1	10,000	6	479,000
Havana to Mouth	7	\$502,330	109	\$1,128,350	116	\$1,630,680

*The Ratios* of leading quantities of the lower division to the whole valley are as follows:

Description.	La		
	Havana to La Grange.	Grange to Mouth.	Havana to Mouth.
All areas under flood of 1844.....	27.0	37.6	64.6
Lands only under flood of 1904.....	27.3	39.1	66.4
Ponds, sloughs, etc. (low water) of 1901	33.0	24.7	57.7
Rived Bed (low water of 1901).....	12.3	31.1	43.4
Reclamation (Area in Drainage and Levee Districts) .....	40.1	43.3	83.4
Damage Claims .....	25.6	10.6	36.2

It will be noted that this division includes about two-thirds ( $\frac{2}{3}$ ) the lands, one-half ( $\frac{1}{2}$ ) the water, five-sixths ( $\frac{5}{6}$ ) the reclamation, and one-third ( $\frac{1}{3}$ ) the claims for damages.

It will be noted further that the lands below La Grange exceed those above by about fifty per cent (50%), while the ponds, sloughs, etc., are greatest



above La Grange, and the river bed greatly in excess below. Reclamation is about equal above and below La Grange. Damage claims against the Sanitary District below La Grange are about forty per cent (40%) of those above and this may be due, in part, to the cutting down of Kampsville dam by two (2) feet (Topic 22). Again (Topic 12), of all lands outside the river bed and below the high water of 1844, seventy-six per cent (76%) are in Drainage and Levee Districts above La Grange and sixty-five per cent (65%) below, and the effect on flood regimen is important.

**22.** *The Federal Dams* at La Grange and Kampsville were constructed under authority of Congress, Act of June 14, 1880, and the project of Captain J. G. Lydecker, of May 10, 1880, for the purpose of completing the slack-water system instituted by the state dams at Henry and Copperas Creek (Topic 15). These dams are respectively one hundred fifty-two and one-tenth (152.1) miles and one hundred ninety-eight and one-tenth (198.1) miles below Utica.

*The La Grange Dam and Lock* was opened for navigation October 21, 1889, and completed December 1, 1890. The low water of 1879 at this point corresponds to the low water of 1871 at Henry and 1873 at Copperas Creek and has since been used as the low water plane and is one hundred sixty-one and eighty-one hundredths (161.81) feet below Chicago datum by the survey of 1902-4. The crest of the dam is eight hundred and twenty (820) feet in length, and is seven and four-tenths (7.4) feet above the low water of 1879. The depth on the lower mitre sill is seven (7) feet below the low water of 1879 and

the depth on the upper mitre sill is seven and three hundredths (7.03) feet below the crest of the dam. The La Grange dam is fifty-nine and three-tenths (59.3) miles below the Copperas Creek dam and the low water declivity is seven and five-tenths (7.5) feet, or the crest of the dam is one-tenth (0.1) foot below low water at Copperas Creek. The low water declivity in 1893 and 1894 was one and twenty-seven hundredths (1.27) feet when the water stood five-tenths (0.5) foot on crest of dam and this corresponds to a back water elevation one and fifteen-hundredths (1.15) feet, more or less, above natural low water at Copperas Creek when water stands at crest of La Grange dam. (See T. 15.) From Havana, the distance is forty-two and two-tenths (42.2) miles and the low water declivity six and six-tenths (6.6) feet, or at an elevation eight-tenths (0.8) foot below crest of dam.

*The Kampsville Dam and Lock* was opened for navigation September 30, 1893. The low water of 1879 at this point is one hundred seventy and ninety-four one-hundredths (170.94) feet below Chicago datum by the survey of 1902-4. The crest of the dam is twelve hundred (1,200) feet in length and is seven and sixty-seven hundredths (7.67) feet above the low water of 1879, the depth on the lower mitre-sill is seven (7) feet below low water of 1879 and the depth on the upper mitre-sill seven and twenty-seven hundredths (7.27) feet below crest of dam. The Kampsville dam is forty-six (46) miles below La Grange dam, and the low water declivity is nine and thirteen hundredths (9.13) feet, or the crest of the dam is one and forty-six hundredths (1.46) feet below low water at La Grange. The low water declivity in



1894 was one and forty-nine hundredths (1.49) feet with forty-seven hundredths (0.47) foot on the Kampsville dam and five tenths (0.5) foot above low water of 1879 at La Grange and this corresponds substantially to the difference in level (1.46 feet) between the crest of the Kampsville dam and low water at La Grange. The Kampsville dam is thirty-one and five-tenths (31.5) miles above Grafton and the low water declivity in 1894 was four and two hundredths (4.02) feet at a stage of twenty-four hundredths (0.24) feet at Kampsville and one and thirty-six hundredths (1.36) feet on gauge at Grafton. This declivity varies greatly with low water stages in the Mississippi (T. 21). The cutting down by two (2) feet of the Federal dams was authorized by joint resolution of Congress, April 21, 1904, and the work at Kampsville was done in 1904-6. Work began at La Grange in 1907, but was abandoned. The Kampsville dam was lowered two (2) feet or to elevation five and sixty-seven hundredths (5.67) feet above low water of 1879. The effect of this lowering is apparent in the moderate damage claims opposite the Kampsville pool. (T. 12 and 13.)

*A Navigable Depth* of seven (7) feet is provided for by the Federal dams at La Grange and Kampsville, or one (1) foot more than was provided in the State works at Henry and Copperas Creek. (T. 15.) The pools have been dredged to correspond to the lock depths from Copperas Creek to the mouth.

*The Appropriations* for the lock and dam project of 1880, including dredging of channel, have been up to June 30, 1913, one million, seven hundred and ten thousand, eight hundred and thirty-seven dollars and

eighty-one cents (\$1,710,837.81). This includes an unexpended balance of thirty-eight thousand, three hundred and thirty-seven dollars and eighty-one cents (\$38,337.81) from prior appropriations. Estimate for completion of project, ninety-two thousand dollars (\$92,000.00). Additional expenditures for operation and maintenance, three hundred and five thousand, one hundred and seventy-five dollars and twenty-six cents (\$305,175.26). The expenditures under the earlier project for dredging in an open channel were (approximately) from 1869 to 1879 three hundred and ninety-three thousand, three hundred and seventy-nine dollars (\$393,379.00). For detail, see appendix.

**23.** *The Shrinkage of the River Bed* is shown by the profiles of different surveys. The profiles of record between Copperas Creek dam and the mouth are those of John B. Preston, 1857-8, the Wilson profile of 1867, the Lydecker profile of 1879 and the profile of the Ernst Board from soundings made in 1902-3 (Survey of 1902-4). The Preston profile, with bar corrections by Abert, shows correctly the general character of the river, but a careful examination thereof indicates that the soundings are too infrequent and not sufficiently located for clear comparison. The profile from the Federal survey of 1867, both by the report and by critical examination, appear to show the river bed accurately in the natural condition and before considerable change had occurred through the inhabitation of the basin; but owing to error in levels, below Beardstown, the adjustment has been made at ruling points by depths on bars, and is therefore approximate.



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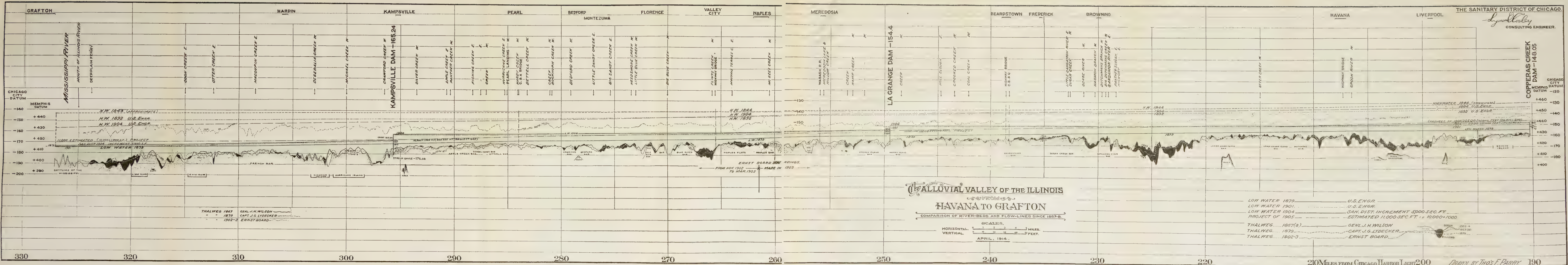
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THE SANITARY DISTRICT OF CHICAGO.  
Lyndon C. Colby  
CONSULTING ENGINEER.

CHICAGO CITY DATUM  
MEMPHIS DATUM  
COPPERAS CREEK DAM - 148.05

THE ALLOVIAL VALLEY OF THE ILLINOIS  
FROM  
HAVANA TO GRAFTON  
COMPARISON OF RIVER-BEDS AND FLOW-LINES SINCE 1867-8

SCALES.  
HORIZONTAL 0 1 2 3 4 5 MILES.  
VERTICAL 0 10 20 30 40 50 FEET.  
APRIL, 1914.

LOW WATER 1879 U.S. ENGR.  
LOW WATER 1901 U.S. ENGR.  
LOW WATER 1904 SAN. DIST. INCREMENT 5000 SEC. FT.  
PROJECT OF 1905 ESTIMATED 11,000 SEC. FT. ± 10,000 ± 1000  
THALWEG 1867(8) GENL. J. H. WILSON  
THALWEG 1879 CAPT. J. G. LYDECKER  
THALWEG 1902-3 ERNST BOARD





The Lydecker profile of 1879 is made from elaborate soundings and has been definitely referred by the precise levels of the survey of 1902-4. The profile of 1902-3 by the Ernst Board (soundings below Naples, November, 1902, to March, 1903, and above Naples in 1903) for thalweg, show the river bed thirty-six (36) years after the Wilson profile and twenty-four (24) years after the Lydecker profile, thirteen (13) years after the closing of the La Grange dam and nine (9) years after the closing of the Kampsville dam. These three profiles are plotted to same scale and plane of reference and are shown by the exhibit hereto attached, together with a number of lines referred to later.

*Filling is Indicated* by the three profiles, the profile of 1902-3, being generally higher than that of 1879 and the profile of 1879 being generally higher than that of 1867. The bars in the river were dredged to a depth of four feet in 1867-79, and this fact is indicated. The two dams were built in 1880-93, after which dredging in the pools and below Kampsville was resumed, and the effect of this is also indicated. The large proportion of shallows and bars below Havana which have undergone deepening and the small proportion of deep pools which have deteriorated renders the profile comparisons less significant, yet the deep pools generally show filling and the bars also in some localities. It was noted (T. 16) that the Henry and Copperas Creek pools did not show material depreciation until after 1889, some seventeen (17) years and eleven (11) years respectively after the closing of the dams, the detritus from the tributaries being impounded

in the back waters and overflowed lands; so radical depreciation was not due in 1902-3 in the La Grange and Kampsville pools. It is reported, however, by land owners in the lower valley that such depreciation has since occurred and a survey is required to show the facts.

*Discharge Measurements* represent phasing conditions and backwater effects from the Mississippi and are too few in number for comprehensive analysis. From the observations made in 1888-9, at La Grange and Kampsville, the bank-full capacity (twelve-foot stage) corresponded to thirty thousand (30,000) second-feet at La Grange and forty thousand (40,000) second-feet at Kampsville. (Report Capt. W. L. Marshall, 1890.) Measurements made in 1904, at Beardstown and Pearl, taken at their face value, indicate a diminution in bank-full capacity of about twenty per cent (20%) (Survey of 1902-4), occasioned presumably by the dams.

**24.** *The Effect on Stage* of an increment of water from Lake Michigan and the improvement of navigation through such increment, was the subject matter of discussion and official action from the project of John B. Preston 1857-8, to the Wilson-Gooding Report of 1868, but was then dismissed by reason of the excessive cost, due to an illy-considered design for the feeding channel across the Chicago Divide. The project on the basis of a deep water channel of not less than fourteen (14) feet was resumed in connection with the Chicago sanitary problem and promoted from August, 1885, to the legislation of 1889. The early history and investigations are set forth at length in Topic 17, relating to the



division above Havana, and it is only necessary here to deal with the proposition since the legislation of 1889.

*Captain W. L. Marshall*, in his report of February 28, 1890, publishes tabulation of flow measurements, made at La Grange and Kampsville in 1888-9 and deduces therefrom the stages of water which will be occasioned by increments of five thousand (5,000) second-feet and ten thousand (10,000) second-feet and a natural low water of one thousand (1,000) second-feet, as follows:

Locality.	Miles from Utica.	5,000 s. f.	10,000 s. f.
La Grange .....	152.1	3.0'	5.5'
Kampsville .....	198.1	2.3'	4.5'

*Lyman E. Cooley* gives estimates of the stages produced by increments of two thousand (2,000) second-feet, five thousand (5,000) second-feet and ten thousand (10,000) second-feet with a natural low water volume of twelve hundred (1,200) second-feet, all as prepared for the legislation of 1889, and officially reported to the Sanitary District in 1890 (P. 65-9, Lakes and Gulf Waterway, 1891):

Locality	Miles from Utica.	2,000 s. f.	5,000 s. f.	10,000 s. f.
Havana .....	109.9	[3.3*]	[4.6*]	[6.4*]
Sangamon River .....	129.8	2.5'	4.2'	6.3'
La Grange Dam.....	152.1	1.3'	3.1'	5.5'
Kampsville .....	198.1	1.0'	2.5'	4.5'
Mississippi River .....	229.6	0.3'	0.7'	1.3'

\*Interpolated.

*The Ernst Board* made elaborate surveys in 1902-4 and developed the fourteen (14) foot project (Aug.

26, 1905, H. R. 263, 59th Cong., 1st Sess.). The Board does not report the effect on stage of an increment of five thousand (5,000) second-feet on a natural low water of one thousand (1,000) second-feet, but does state that the present increment of four thousand two hundred (4,200) second-feet “will make practicable the maintenance of an open channel considerably deeper than the seven (7) feet now provided by these structures” (dams and locks). A flow line is worked out of an increment of ten thousand (10,000) second-feet when the river is improved by a dredged channel two hundred (200) feet wide on bottom and fourteen (14) feet below such flow line. Some three-fourths ( $\frac{3}{4}$ ) the channel excavation is below Havana and more than half below Beardstown, so the stages are materially modified from natural conditions. Again, the stages near the mouth are arbitrarily determined by the projected dam at Alton. Subject to the foregoing qualifications, the stage produced by an increment of ten thousand (10,000) second-feet on a natural low-water volume of one thousand (1,000) second-feet is estimated as follows:

Locality.	Miles from Utica.	Stage Feet.
Havana .....	109.9	5.80'
Sangamon River .....	129.8	5.60'
La Grange Dam.....	152.1	4.80'
Kampsville .....	198.1	4.00'
Mississippi River .....	229.6	5.00'

Remarks: Grafton Gauge 6.04 ft. (Woermann Profile).



*The Experience with Steady Flow* is indicated by the low water profile of 1901, corresponding to an increment of three thousand four hundred (3,400) second-feet at Lockport and the low water of 1904 corresponding to an increment of five thousand (5,000) second-feet (approx.), assuming that the stage at Havana for these increments is not affected by the La Grange dam, and that the stage immediately below the La Grange dam is not affected by the Kampsville dam and, assuming further that the stage in the Mississippi River corresponds to two and six-tenths (2.6) feet on the Grafton gauge, as adopted for the improvement plane for the Mississippi River since the accession of flow through the Chicago Drainage Canal (letter of C. W. Durham, February 24, 1914). This improvement plane corresponds to the low water in the navigation season of 1901 and 1910 and 1911. The results are as follows:

Locality.	Miles from Utica.	1901 3400 s. f.	1904 5000 s. f.
Havana .....	109.9	4.3 ft.	6.1 ft.
La Grange Dam.....	152.1	2.9	4.8
Kampsville .....	198.1	2.4	2.8 to 3.2
Mississippi River ....	229.6	1.5	1.5

Remarks: Grafton Gauge, 2.6 ft.

These results indicate that an increment of four thousand one hundred sixty-seven (4,167) second-feet (250,000 minute-feet), which is the volume conceded by Federal permits, would give about five and two-tenths (5.2) feet above standard low water to Ha-

vana, three and eight-tenths (3.8) feet at La Grange and two and seven-tenths (2.7) feet at Kampsville. Prior to the present lock and dam project (1880) a channel four (4) feet deep had been produced through all the bars and these stages would give in such channels seven (7) feet or more from Havana to Pearl and six and seven-tenths (6.7) feet at Kampsville, diminishing to five and five-tenths (5.5) feet at the mouth. The last profile from soundings in 1902 shows that a depth better than seven (7) feet would obtain below Kampsville, but that depths on shoals in the Kampsville pool have so depreciated that some dredging would be required in the lower end of the pool to give the equivalent depth of seven (7) feet contemplated by the lock and dam project.

*The Comparison* shows that the estimates of Marshall and Cooley for stages due to five thousand (5,000) second-feet were very conservative in respect to actual stages produced during the low water of 1904; in other words, steady flow produces higher stages than is indicated by unsteady flow and phasing conditions.

*The Increment of 10,000 Second-feet* in its effect on stage is not determined by experience. The project profile of the Ernst Board (Survey 1902-4) is based on a material improvement in the depth and capacity of the stream and is therefore not a criterion of stages in the natural river bed. The flow line is everywhere lower than the estimates of Marshall and Cooley and coincide with the experience stage for half the volume at La Grange, being slightly below the same at Havana and somewhat above at Kampsville; in other words, the projected im-



provement in the river bed seems to be equivalent to half the increment; again, the stages due to an increment of ten thousand (10,000) second-feet and the projected fourteen (14) foot channel are less than those produced by the dams except under low water conditions at the upper ends of the pools.

*The Conclusions* from the foregoing analyses are that an increment of four thousand one hundred sixty-seven (4,167) second-feet, conceded by Federal permits, would give seven (7) feet on the Lydecker profile of 1879, with the aid of some slight dredging between Pearl and Hardin and that an increment of five thousand (5,000) second-feet would give a clear seven (7) feet throughout. Under the profile of 1902-3, some re-dredging would be required on the bars which have filled since the lock and dam project was adopted. The river below Havana, as contrasted with the river above, has much greater declivity, larger channel capacity, and a better defined stream bed, a less proportion of deep pools and a better sustained low water volume, all of which indicate difference in regimen and in the effect of increments of water.

**25.** *The Removal of the Dams*, State and Federal, and the improvement of the stream by dredging in conjunction with an increment of water from Lake Michigan has been the declared policy of the State of Illinois since the Main Channel was authorized in 1889. This was the original conception and its definite promotion began with the Preston project of 1857-8, but it was dismissed temporarily on false premises in 1867-8 to be resumed in 1885-9. The history of the matter is set forth at length in

Topics 18 and 19 and it is only necessary to recall here the leading facts respecting the Federal dams.

(a) By joint resolution in 1889, the General Assembly of Illinois requested the United States to stop work on the dams at La Grange and Kampsville and change its project to an open channel improvement by dredging in conjunction with an increment of water from Lake Michigan, and to cooperate in the production of a deep waterway, not less than twenty-two (22) feet deep across the Chicago Divide, not less than fourteen (14) feet on a progressive plan for a greater depth in the upper Illinois, and for all the depth feasible by the aid of a water supply in the lower Illinois.

(b) By joint resolution in 1897 requesting the removal of the Federal dams at La Grange and Kampsville, which meantime had been completed, and reiterating the policy laid down in the joint resolution of 1889.

(c) By the Constitutional Amendment of 1908, based on the report of the Internal Improvement Commission of 1907, which defined an ultimate channel development twenty-four (24) feet deep to Peoria and eighteen (18) to twenty (20) feet deep thence to the Mississippi River. The preliminary depth below Joliet to be not less than fourteen (14) feet as outlined in the preceding joint resolutions.

*The Feasibility* of the fourteen (14) foot project was officially recognized by the Barlow Board in 1900-1, and the project was definitely planned and estimated from elaborate surveys and examinations in the Report of the Ernst Board in 1905. The project was further endorsed by the Bixby Board



in its report of 1909, which was particularly devoted to the determination of a fourteen (14) foot project below St. Louis. In fact, the practicability of the Illinois program has never been questioned in official reports, but adverse opinions have been expressed respecting its expediency.

*The Congress*, by the joint resolution of April 21, 1904, authorized the cutting down of the crests of the Federal dams by two (2) feet, and this was done by the Sanitary District at Kampsville in 1904-6, but was not done at La Grange. The removal of these dams was discussed before the Senate Committee on Commerce in 1912 (Topic 19), but the conclusion is in abeyance pending action respecting the State dams at Henry and Copperas Creek.

*The Special Board of Engineers*, appointed in 1910, to consider, among other things, co-operation with the State of Illinois, made a preliminary report on January 23, 1911, which was virtually withdrawn by the President's message of December 21, 1911, on the protest of the Governor of the State and the Chairman of the Internal Improvement Commission, and by reason of the fact that the General Assembly had not provided for conferees. No further action having been taken, the Board adopted its preliminary findings in the final report of August 15, 1913, (H. R. 762, 63d Cong., 2d Sess.), for a navigable depth of eight (8) feet, to be obtained by the aid of the present dams—Federal and State—and a water supply of one thousand (1,000) second-feet only, said depth to be increased in the future to nine (9) feet, or that of the Ohio River improvement, if justified by growth of commerce. The Board of Engineers for

Rivers and Harbors (December 16, 1913), in reviewing the report reiterates its findings of January 30, 1911, so far as relates to Illinois:

(a) The Lower Illinois Improvement should be deferred until the diversion of water is finally determined. "Not only may this affect the attitude of the State toward the work (Upper Illinois), but also when the approximate minimum flow is known, it may be found advisable to substitute open channel work for the four existing locks and dams that are retained in the plan of the Special Board."

(b) The State should be conceded full control of water power in the Upper Illinois, but in consideration thereof it should complete this part of the work without aid from the United States.

(c) As a condition precedent to any Federal cooperation the cost of remedial works for correction of lake levels and all damages between Lake Michigan and the Mississippi River should be assumed in perpetuity. The cost of such remedial work, as limited to the Niagara and St. Clair Rivers, is estimated at four hundred and seventy-five thousand dollars (\$475,000) with fifteen thousand dollars (\$15,000) annually for maintenance.

Respecting the Illinois program, Congress has not gone further than to authorize the determination of projects for a navigable depth of fourteen (14) feet between the lakes and the gulf, and through the International Commission provided for in 1902 and the Special Board provided for in 1910, to determine the effect of diversion on lake levels and the remedies therefor. The War Department, however, has undertaken to test its authority under the Act of March



3, 1899, by bringing an issue respecting the diversion at Chicago of any volume of water, in excess of four thousand one hundred and sixty-seven (4,167) second-feet and this issue has been pending since March 23, 1908 (additional bill October 6, 1913), and the officers of the Department may be subject to some embarrassment in giving affirmative interpretations to Acts of Congress and reporting deep water projects which are conditioned by a large water supply diverted from the Great Lakes.

In view, however, of the fact that the issue, as now defined, is to restrict any volume in excess of four thousand one hundred and sixty-seven (4,167) second-feet, and that such volume is entirely adequate to a depth of eight (8) feet in the Illinois River, without the aid of the State and Federal dams, and at a cost for dredging of less than the official estimate for eight (8) feet with the dams, it is presumed that the recommendation of the Special Board, made in 1911, and based on a volume of one thousand (1,000) second-feet is now obsolete and that the caution of the Reviewing Board, as above set forth (a), is justified. The fact is the volume of water conceded in the Federal issue, warrants the removal of all the dams in the Lower Illinois, irrespective of the question of whether deeper water than eight (8) feet is wise or otherwise.

**26.** *Flood Overflow* of the Mississippi bottoms opposite the mouth of the Illinois begins at about the seventeen and five-tenths (17.5) foot stage on the Grafton gauge and becomes general at about the twenty-two and five-tenths (22.5) foot stage, such stages corresponding in elevation to the natural low

waters between Sangamon River and Copperas Creek. The following floods have exceeded stages of twenty-two and five-tenths (22.5) feet on the Grafton gauge. The record being complete from 1880 to 1913, inclusive:

Year.	Stage.	Authority.
1844 .....	32.16'	Woermann.
1851 .....	30.64'	Woermann.
1858 .....	30.77'	Woermann.
1881 .....	22.9'	Durham.
1882 .....	23.1'	Durham.
1883 .....	23.14'	Woermann, Durham 23.3'
1892 .....	25.7'	Durham, Woermann.
1903, June.....	28.65'	Woermann, Durham 28.4'
1904, May.....	24.08'	Woermann, Durham 24.0'
1908 .....	23.8'	Durham.
1909 .....	22.6'	Durham.
1912 .....	23.5'	Durham.

*Overflow Stages* were absent in the following years as indicated by readings of less than seventeen and five-tenths (17.5) feet on the Grafton gauge:

Year.	Stage.	Authority.
1885 .....	17.3'	Durham.
1887 .....	13.6'	Durham.
1889 .....	14.4'	Durham.
1890 .....	14.4'	Durham, Woermann 14.64'
1891 .....	14.9'	Durham.
1893 .....	14.3'	Durham.
1894 .....	14.3'	Durham.
1895 .....	7.6'	Durham.
1898 .....	16.1'	Durham.
1900 .....	17.3'	Durham.
1901 .....	16.6'	Durham.
1910 .....	14.3'	Durham.
1911 .....	15.4'	Durham.

It appears that in a period of thirty-four (34) years, thirteen (13) high waters have ranged within the banks, that twelve (12) high waters have corresponded to varying degrees of overflow and that



nine (9) high waters have produced complete overflows.

The backwater is material in its effect in the lower valley and the profiles of great floods indicate that such effects reach up to and above Beardstown.

*Measured Flood Stages* in 1904 at Twelve Mile Island above the mouth ranged from sixty thousand (60,000) to one hundred thousand (100,000) second-feet, varying with the relative stage in the Mississippi.

*Five Characteristic Floods*, referred to the standard low water of 1879 in the Illinois, and to plus one and eight hundredths (1.08) feet on Grafton gauge, are tabulated as follows:

Locality.	Below Utica.	1844.	June, 1903.	April, 1904.	1883.	1913.
Copperas Creek....	92.8 miles	24.8'	12.4'	20.7'	19.7'	20.5'
Havana .....	109.9 "	21.9'	12.2'	19.8'	20.5'	20.0'
Sangamon River (Browning) ....	129.8 "	22.6'	....	20.1'	21.4'	22.8'
Beardstown .....	141.3 "	22.7'	14.6'	20.2'	22.0'	22.0'
La Grange .....	152.1 "	23.3'	16.0'	20.4'	21.8'	....
Meredosia .....	158.7 "	24.1'	16.7'	20.3'	21.4'	22.8'
Pearl .....	186.6 "	26.5'	20.6'	19.4'	20.4'	20.8'
Kampsville .....	198.1 "	29.3'	24.2'	20.7'	22.1'	22.15'
Hardin .....	208.4 "	30.2'	25.6'	20.4'	22.3'	....
Grafton .....	229.6 "	31.1'	27.5'	18.8'	22.1'	19.5'

*The Flood of 1884* is the greatest known at St. Louis and in the Illinois Valley and also in the lower part of the Missouri River Basin and the Upper Mississippi River Basin. It produced extraordinary readings on the gauges at Peoria and above and in the lower part of the Illinois River, but these stages are greatly reduced opposite the broad bottoms from Havana to Beardstown, although still higher than any other known flood. Presumably the stages would

have continued undiminished had overflow been limited at the Great Sangamon bottoms.

*The Flood of June, 1903*, was second to 1844 at St. Louis, exceeded 1844 in the Missouri River at Kansas City and was an extraordinary flow in the Upper Mississippi, but was only a bank-full flood in the Illinois, except as affected by back-water, which reached above Beardstown. Both this flood and that of 1844 are characteristic of back-water effects.

*The Flood of 1904* represents very uniform flood conditions throughout the Illinois River Basin with the Mississippi River nearly at a relative stage, so that its profile has been taken as standard. This is the highest general flood for the last forty (40) years and its measured volume at Pearl (117,000 second-feet) may be the maximum, owing to absence of backwater.

*The Floods of 1883 and 1913* are both higher than 1904, from Havana to the mouth, due to floods from the central basin, but the excess in stage lessens down stream. The flood of 1913, at the mouth of the Sangamon was higher even than that of 1844, but is seven-tenths (0.7) foot lower at Beardstown and identical with 1883, thence falls off rapidly in relation to 1844, but is better sustained than 1883, independent of Mississippi back-water. It appears, therefore, that the central basin is an important flood factor in the lower division of the river, as well as the back-water from the Mississippi. It may be, however, that the extensive drainage work and straightening of channel in the lower Sangamon basin, together with the very large proportion of the bottom lands under levee opposite the La Grange



and Kampsville pools, executed in recent years, have materially accentuated the flood stage of 1913.

**27.** *A Summary of the Salient Facts* respecting the lower division of the Lower Illinois Valley is set forth as follows (see also T. 20) :

(a) The Lower Division includes about two-thirds ( $\frac{2}{3}$ ) the area of the valley, one-half ( $\frac{1}{2}$ ) the water, five-sixths ( $\frac{5}{6}$ ) of the lands under reclamation and one-third ( $\frac{1}{3}$ ) the amount of damage claims from overflow. Damage claims, opposite the Kampsville pool, are about forty per cent (40%) of those opposite the La Grange pool, assumed to be due in part to the cutting down by two (2) feet of the Kampsville dam in 1904-6. Reclamation represents seventy-two per cent (72%) of all lands subject to overflow outside the river bed and this is important on flood regimen.

(b) The bars below Copperas Creek were dredged to a depth of four (4) feet prior to 1880. The Federal dams and locks were authorized in 1880, and the work at La Grange opened in 1889-90, and at Kampsville in 1893. The locks are of the same dimensions as those at Henry and Copperas Creek, but have one (1) foot additional or seven (7) feet on the mitre sills. The expenditure under the project of 1880, including dredging, was one million, five hundred and sixty-six thousand, nine hundred and eighteen dollars and ten cents (\$1,566,918.10), to June 30, 1913.

(c) The fill in the river bed between the profiles of 1867 and 1879 and 1902-3 is limited to deep places and a few bars, while other bars show the effect of dredging, but the time under dams has been too short

for tributary contributions to reach the main channel in notable quantities, and the steeper declivity and smaller proportion of deep water lessens the apparent effect in relation to the Upper Division. The measurements of 1903-4, in comparison with 1888-9, seem to indicate a diminished bank-full capacity, presumably due to the dams.

(d) The increment of four thousand one hundred sixty-seven (4,167) second-feet, conceded by Federal permits, gives seven (7) feet in the channel of 1879, with limited dredging below Pearl (and under the improvement plane recently adopted for the Mississippi River).

An increment of five thousand (5,000) second-feet gives seven (7) feet everywhere, except a few bars which require redredging.

The official profile for the fourteen (14) foot project (Ernst Board, 1905,) by dredging and an increment of ten thousand (10,000) second-feet, actually corresponds to the experience profile for an increment of five thousand (5,000) second-feet; in other words, the channel improvement by dredging in this project seems to be equivalent to five thousand (5,000) second-feet. A depth of eighteen (18) to twenty (20) feet by means of dredging, and an increment of fifteen thousand (15,000) second-feet as suggested by the Report of 1907 (Internal Improvement Commission of Illinois) is more feasible than supposed.

(e) The Federal dams can form no part of a deep water project and must be removed as a condition precedent. The fall over the dams on the experience profile of 1904 was, at La Grange, four and two-tenths (4.2) feet, and at Kampsville five and nine-



tenths (5.9) feet, or several times that at Henry and Copperas Creek, so these dams are far more potent in their effect on ordinary flow and bank-full capacity. They are regarded as unnecessary by the Ernst Board (1905) with an increment of four thousand two hundred (4,200) second-feet.

The Special Board which reported in 1911 and again in 1913 proposes to utilize these dams (also the State dams) in a project for eight (8) feet and a volume of one thousand (1,000) second-feet, but the Reviewing Board does not concur and suggests that the project be deferred pending the determination of the minimum increment from Lake Michigan, which may render them unnecessary. The Bill of Complaint of the United States concedes an increment of four thousand one hundred sixty-seven (4,167) second-feet, so no real issue exists respecting such increment of water as justifies the removal of the Federal dams.

(f) Back-water effect from the Mississippi River is a serious factor in many overflow floods, and again floods local to the central basin are sometimes imposed upon head water floods with extraordinary stages below Havana. This latter menace has been greatly accentuated by drainage works in the Lower Sangamon and by the reclamation of some seventy-two per cent (72%) of the overflow areas. In addition, local reports indicate that the tributary detritus is now coming to the main stream and that the pools are rapidly depreciating. These facts, together with the relatively higher dams and the attendant checking of flow, indicate that the early removal of the Federal dams is of even greater importance than the removal of the State dams.

### **E—Conclusion.**

28. (1.) *The Illinois River Basin* has some twenty-eight thousand (28,000) square miles and is more uniformly fertile than any other basin of like magnitude. Its topographic relief is very gentle and its surface in nature has a large proportion of swamp and a small proportion of timber in the northern confines. The flood volume was moderate, compared to the streams of hill countries, and its low water volume was originally well sustained until the swamps were drained, when extraordinary low water ensued, due to non-permeable subsoils and water consumption by vegetal cover in the growing season. The general reclamation of the swamps and tillage has made floods more erratic, prolonged the low water season and diminished its volume and enormously increased the supply of detritus.

(2.) The Illinois River was originally an outlet of Lake Michigan and the floods of its source stream, the Desplaines, traversed the Chicago Divide to both the lake and the river until 1909.

The Illinois and Michigan Canal was projected so as to feed from Lake Michigan and the old outlet was restored on a much larger scale by the opening of the Drainage Canal in 1900, with a capacity of about three-quarters ( $3/4$ ) of the average flow of the Illinois River at its mouth.

The Illinois River is the remnant, or survival, of the ancient outlet, and the very low declivity of the Lower Illinois, its course and character of bed and the low elevation of its bottom lands, indicate only partial adaptation to modern conditions. The stream



is unable to cope with the increasing burdens due to inhabitation, and the restoration of a large and persistent flow, in a suitable channel, is conservative against the agencies which promote a decaying river bed.

(3.) The Illinois Basin has two divisions. The Upper Division above Peoria is comparatively recent and non-erosive, so that the upper half of the Lower Illinois is less changed by detritus, and has a slope of less than one (1) inch per mile; while the lower half has a slope of two (2) inches per mile, with better filled-in bottoms, representing the more friable soils of the central and lower basins. The flood regimen is thus divided and may come from either part of the basin separately, or in order of succession, or the central basin flood may be imposed on high water from above. All these conditions do obtain, but ordinarily the Upper Basin flood follows that of the central basin. Again, floods in the Mississippi are relatively higher and have a profound effect on the valley with only twenty-eight (28) feet fall in two hundred and thirty (230) miles, and occasionally a flood like that of 1903 in the Missouri will back in to the Illinois Valley. Some seventy-two per cent (72%) of the overflow lands below Havana are under levee or undergoing reclamation, and some twenty-eight per cent (28%) above. Such restriction of flood overflow must have a profound effect on flood regimen, but these reclamation works are comparatively recent and have not yet manifested their effect in a great flood, unless that of 1913 be indicative. The effect of this reclamation is to restrict a further development of Illinois fisheries which, in proportion

to extent, are the most valuable fresh water fisheries in the United States.

(4.) The first project for the radical improvement of the Lower Illinois River was by John B. Preston, in 1857-8, by means of an increment of water from Lake Michigan, but this was dismissed by the Federal Reports of 1866-8, by reason of the excessive cost, due to an illy-considered design for the feeding channel across the Chicago Divide.

The lock and dam scheme followed with the State dam at Henry, opened in 1871, and the State dam at Copperas Creek, opened in 1877, the United States co-operating in the dredging of channels. The Federal dams followed, the dam at La Grange opened in 1889-90, and the dam at Kampsville opened in 1893. The lock and dam project was opposed in official circles and by steamboat interests, as an error in an alluvial stream of slight declivity. The riparian interests, at the time, had a nominal value, and only recently under reclamation have they become important; otherwise, the lock and dam scheme would not have been tolerated.

(5.) The Chicago Sanitary Project and its waterway relations, authorized by the General Assembly in 1889, restored the original conception of the improvement of the Lower Illinois by means of an increment of water from Lake Michigan, in conjunction with dredging, and such legislation contemplated removal of the State and Federal dams, and the development of a deep waterway progressively from a preliminary depth of fourteen (14) feet below Joliet. The report of the Internal Improvement Commission of Illinois for 1907, defined the depth in



extension of the Chicago Drainage Canal at twenty-four (24) feet to Peoria, and eighteen (18) to twenty (20) feet thence to the Mississippi, and the Constitutional Amendment of 1908 followed and provided for the expenditure of twenty million dollars (\$20,000,000) for the development of the waterway and incidental water power in the Upper Illinois Valley, between Lockport and Utica.

The Board of Engineers in 1909 determined the feasibility of producing fourteen (14) feet at extreme low water from St. Louis to the Gulf.

(6.) The State and Federal dams still remain in the river and have occasioned vexation in spirit and grievous claims for damage against the Sanitary District of Chicago which would have been avoided had the dams been promptly removed and a dredging program entered upon. The claims now aggregate over eight million dollars (\$8,000,000) and the growing riparian interests of the valley are insisting that the water required for the sanitation of Chicago shall be restricted until conditions are changed.

(7.) The present study and the profiles hereto attached show extraordinary depreciation in the pools created by the State dams at Henry and at Copperas Creek, such depreciation amounting to thirty per cent (30%) in the original low water channel and lessening the bank-full capacity by fifteen (15) to twenty (20) per cent. This effect occurred prior to the soundings of 1903, since which no general survey of the river has been made. The pools created by the Federal dams show some depreciation in the deep places and betterments due to dredging on the shoals with some exceptions, but these

pools had not been in existence long enough prior to 1902-3 for the tributary contributions to reach the main stream, but local information indicates that much filling has since occurred. These dams are relatively much higher than the State dams and in themselves appear to have materially diminished the bank-full capacity of the stream. If the tendencies, exhibited by the survey of 1903, continue, they will radically diminish the capacity of the river bed even though depths for navigation be maintained by dredging narrow channels through the bars, and the effect will be to lift the horizon of the river bed and the overflow plane, to the detriment of unreclaimed lands and the peril of reclamation works.

(8.) The salvation of the Illinois Valley is the immediate removal of both State and Federal dams and a program of radical deepening by dredging, so as to greatly increase the capacity of the river within its proper banks and the supplying to such deepened stream of a large and constant volume of water for the maintenance of a scouring velocity. There is no limit to the depth which may be produced except the increment of water, and if the channel be so fashioned as to give the best results, it will have a larger surplus capacity for natural drainage than in a condition of nature. The experience with steady flow shows that the increment of four thousand one hundred sixty-seven (4,167) second-feet, conceded by Federal permits, will produce a depth equivalent to that by the dams with nominal dredging at a few points. The Ernst Board (1905) reported that such volume will make practicable a depth considerably greater than seven (7) feet. The conditional appra-



priation of one million dollars (\$1,000,000) made in 1910, if applied to the Lower Illinois, would produce a channel depth of eight (8) feet or more. This is less than the estimate of the Special Board (1911 and 1913), for a similar depth by means of the dams and a water supply of one thousand (1,000) second-feet. As this minimum volume is not in issue in the Federal case at Chicago, the conditions actually exist which led the Board of Review to suggest the open channel treatment as the alternative to the recommendations of the Special Board. There remains, therefore, no physical or other reason why these dams should not be removed and an open channel treatment entered upon without further delay.

(9.) No additional legislation is required for the removal of the State dams. It is a matter of mutual understanding and accommodation between the Canal Commissioners who have charge of the State Works and Trustees of the Sanitary District of Chicago to be brought about through the good offices of the Governor of this State; otherwise, tedious litigation may be involved. The removal of the Federal dams must be sanctioned by Congress. This matter was taken up before the Senate Committee on Commerce in 1912 and consideration deferred, pending action for the removal of the State dams. Again the subject matter is up to the Chief Executive of this State.

LYMAN E. COOLEY.





## APPENDIX I.

**Expenditures on Illinois River.**

## Federal Expenditures.

Appropriated, August 30, 1852.....	\$ 30,000.00
Allotted from appropriation for Western Rivers, 1867..	20,000.00
Executive Allotment, 1869.....	84,150.00
Appropriated, July 11, 1870.....	100,000.00
“ March 3, 1873.....	100,000.00
“ June 23, 1874.....	75,000.00
“ March 3, 1875.....	75,000.00
“ August 14, 1876.....	40,000.00
“ June 18, 1878.....	75,000.00
“ March 3, 1879.....	40,000.00
“ June 14, 1880.....	110,000.00
“ March 3, 1881.....	250,000.00
“ August 2, 1882.....	175,000.00
“ July 5, 1884.....	100,000.00
“ August 5, 1886.....	112,500.00
“ August 11, 1888.....	200,000.00
“ September 29, 1890.....	200,000.00
“ July 13, 1892.....	100,000.00
“ August 18, 1892.....	35,000.00
“ June 3, 1896.....	40,000.00
“ March 3, 1899.....	100,000.00
“ June 13, 1902.....	75,000.00
“ March 2, 1907, above Copperas Creek...	50,000.00
“ March 2, 1907.....	50,000.00
“ June 25, 1910.....	30,000.00
“ July 25, 1912.....	20,000.00
“ March 4, 1913.....	100,000.00
Total, appropriations and allotments.....	\$2,386,650.00
Amount required to complete existing projects.....	92,000.00
Maintenance and operation of locks and dams allotted from indefinite appropriations.....	305,176.26
Survey of fourteen foot waterway, Lockport to St. Louis, June 13, 1902 (Report 1905).....	200,000.00

Of the foregoing, the allotment for 1867, \$20,000, and \$25,000 of the appropriation of 1888, together with some minor allotments not scheduled above, have been applied to surveys.

*The Lock and Dam Project of 1880*, below Copperas Creek, has received all moneys appropriated since 1879, except \$25,000 applied to surveys and

\$50,000 applied to channel improvements above Copperas Creek, and includes a balance from former appropriations.

Balance from appropriations, prior to 1880.....	\$ 38,337.81
Appropriated 1880 to 1913, inclusive.....	1,672,500.00

Total available .....	\$1,710,837.81
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Unexpended June 30, 1913, including \$3,958.67 from other sources .....	147,878.38
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Of the appropriation of \$50,000 for the improvement of the channel above Copperas Creek, there remained unexpended June 30, 1913, including \$144.83 received from other sources.....	7,398.43
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The amount appropriated and allotted prior to 1880, except the appropriation of 1852, \$30,000, and \$20,000 for surveys (1867) and \$38,337.81 carried over to the project of 1880, was.....	550,812.19
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Channel improvement of four feet through bars below Copperas Creek.....	\$393,379.00
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Dredging bars in Copperas Creek pool, and removing snags and wrecks below La Salle, including \$10,973.43 (appx.) for engineering and supervision .....	95,074.29
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Foundation Copperas Creek lock.....	62,358.90
(The division of expenditures above and below Copperas Creek is approximate.)	

The appropriation of \$30,000 in 1852 was expended in dredging bars in 1852-4, and the good effect is noted by Abert in 1866.

The La Grange Dam was opened October 21, 1889, and the cost of operation and maintenance to June 30, 1913, has been.....	171,699.93
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The Kampsville Dam was opened September 30, 1893, and the cost of operation and maintenance to June 30, 1913, has been.....	133,475.33
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The total for operation and maintenance of the Federal Dams has been.....	305,175.26
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### State Expenditures.

The Henry Lock and Dam was opened October 19, 1871, and cost .....	400,000.00
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The Copperas Creek Lock and Dam was opened October 21, 1877, and cost.....	347,747.51
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The total expenditure (from surplus canal revenue)...	\$ 747,747.51
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The cost of maintenance and operation prior to 1890 for the Henry Lock and Dam was.....	\$ 32,615.30
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The cost for the Copperas Creek Lock and Dam was..	38,256.55
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The total cost to 1890 was.....	\$ 70,871.85
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From 1890 to 1913, inclusive, the cost has been.....	
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APPENDIX NO. 2.

A. FLOW RECORD—MAIN CHANNEL OF SANITARY DISTRICT.

Monthly and Yearly Mean Discharges in Cubic Feet Per Minute; Based on Rating Curve for Controlling Works, 1900-1907, and in Addition, Rating Curves for Sluices and Makers' Wheel Ratings, 1908-1914.

Month	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909
January	86,943	295,037	251,661	367,464	327,761	310,030	267,419	318,189	No record	No record
February	138,872	304,836	252,254	344,955	310,180	331,614	277,546	328,023	No record	No record
March	125,935	317,741	253,981	315,652	282,468	332,740	263,602	297,252	No record	No record
April	163,644	265,593	249,884	278,271	296,746	284,245	274,082	297,563	No record	No record
May	193,669	186,382	249,948	274,166	307,522	247,193	283,132	301,878	No record	No record
June	193,542	174,188	244,261	288,709	246,035	247,419	265,224	332,318	No record	No record
July	203,447	188,320	259,365	292,176	273,167	247,387	239,733	335,941	No record	No record
August	214,579	235,930	252,232	271,953	274,389	527,438	205,588	374,957	No record	No record
September	138,417	234,348	257,454	259,837	248,471	260,450	224,428	282,185	No record	No record
October	206,975	230,442	249,310	272,675	240,238	270,604	313,255	252,294	No record	No record
November	228,775	238,743	254,857	281,132	267,089	202,680	311,873	263,689	No record	No record
December	253,621	246,813	321,126	334,216	304,031	235,129	294,415	300,303	No record	No record
Yearly	179,342	242,444	258,145	298,286	281,578	268,616	268,276	307,021	*319,000	*340,000

Month	1910	1911	1912	1913	1914	Remarks.
January	No record	343,165	346,917	375,168	399,221	*Estimated means.  **Mean discharge for the first 6 months 1914.  From 1900 to 1907, inclusive, the Main Channel of the Sanitary District of Chicago discharged over the bear trap dam at the controlling works. The water power station was put in operation on December 28, 1907. *Floods in the Desplaines River have contributed to the flow in the Main Channel since March, 1909, by way of the spillway at Willow Springs.
February	No record	342,432	331,525	364,467	398,827	
March	No record	333,872	340,849	356,812	374,104	
April	No record	340,522	380,404	372,270	393,009	
May	No record	350,248	352,482	433,424	437,839	
June	No record	401,166	381,750	461,047	445,475	
July	No record	428,774	416,952	470,975	.....	
August	No record	415,611	428,545	503,391	.....	
September	No record	425,604	431,331	502,864	.....	
October	399,529	443,098	423,623	476,593	.....	
November	389,439	426,757	411,393	436,337	.....	
December	330,757	392,516	377,695	420,304	.....	
Yearly	358,000*	387,226	382,677	431,581	408,109**	

Compiled from original records by G. H. Hillebrand.

APPENDIX No. 2—Continued.

B. FLOW RECORD—ILLINOIS AND MICHIGAN CANAL.

Monthly and Yearly Mean Discharges in Cubic Feet Per Minute; Based on Rating Curve at Bridgeport Pumping Station.

Month	1900	1901	1902	1903	1904	1905	1906	1907
January	33,710	.....	.....	10,825	23,745	25,891	22,186	17,553
February	38,186	.....	.....	16,901	25,408	28,763	18,097	10,518
March	38,570	.....	.....	10,888	19,731	28,744	18,434	.....
April	31,587	4,451	.....	17,980	21,255	25,047	22,846	3,770
May	28,739	23,309	17,231	24,145	21,523	19,291	24,053	2,964
June	23,188	22,837	5,668	24,736	25,209	24,325	25,416	4,012
July	25,811	23,199	16,876	19,975	25,698	28,196	25,375	5,809
August	23,730	23,288	13,675	15,132	27,641	29,939	27,171	2,860
September	25,977	23,973	9,476	16,546	30,110	26,902	27,446	6,134
October	24,059	24,407	15,182	25,463	28,323	19,053	30,566	8,596
November	22,524	19,511	3,405	27,650	24,739	22,711	28,751	9,236
December	13,780	.....	.....	18,563	24,709	23,050	23,337	3,192
Yearly	27,418	13,818	6,872	19,055	24,832	25,134	24,781	6,200

No record available after 1907; discharge nominal.  
Main Channel used for navigation since July 13, 1910.

Compiled from original records by G. H. Hillebrand.



APPENDIX NO. 3.

RUN-OFF FROM ILLINOIS RIVER BASIN AT PEORIA.

From Report by Jacob A. Harman, C. E., "The Sanitary Investigation of the Illinois River and its Tributaries," State Board of Health, 1901, page 181.

Illinois River Basin Above Peoria

Area, 13,480 square miles.    Rainfall and Run-off.    Annual Summary.

Year.	Run-off Inches.	Rainfall Inches.	Per Cent. Running Off.	(Cubic Feet Per Second.	Second-Feet Per Square Mile.
1890	7.942	33.79	23.6	7,893	.588
1891	5.331	32.30	16.5	5,289	.392
1892	13.555	40.54	33.4	13,396	.994
1893	11.060	28.80	38.4	10,966	.815
1894	4.487	28.72	15.6	4,460	.331
1895	3.364	29.81	11.3	3,338	.247
1896	8.161	36.03	22.6	8,099	.600
1897	11.258	32.63	34.5	11,173	.826
1898	12.013	41.49	29.0	11,923	.884
1899	7.436	31.11	23.9	7,378	.547
Averages . . . . .	8,460	33.52	25.2	8,391	.622
Without flow from I. & M. Canal. . . . .	7,860	33.52	23.4	7,791	.576

NOTE: The flow from Illinois and Michigan Canal to Desplaines River is estimated at 600 cubic feet per second for ten years prior to 1900, which is equivalent to .6 inches of run-off per year, or .0445 second-feet per square mile from entire territory above Peoria.

“The period under discussion has been one of low rainfall, the average for the ten years having been 33.52 inches, while the normal rainfall for Illinois as given by Leverett in ‘Water Resources of Illinois,’ is 37.85 inches, an average annual shortage of 4.33 inches. During that time the rainfall exceeded the normal only two years, viz: 1892 and 1898, the intervening years being regarded as the greatest period of severe drought that has been experienced in this region since it has been settled.”





## SUPPLEMENT.

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### **The Waterway Relations of the Sanitary and Ship Canal of Chicago.**

1. *An Increment of Water* from Lake Michigan for the low water improvement of the alluvial Illinois between Utica and the Mississippi River, was the underlying conception in early projects for an enlarged navigation between Lake Michigan and the Mississippi River. It was the governing idea in the project of John B. Preston in 1857-8, in the report on sewage disposal by the city authorities of Chicago in 1860, in the joint resolution of the General Assembly in 1861, the bill before the Congress was a war measure in 1862, and in the Chicago Waterway Convention of 1863; but it was dismissed as "impracticable at any reasonable cost" by the Federal examination of 1866-7, by reason of an unfortunate design and estimate for the feeding channel across the Chicago Divide.

*The Alternative Lock and Dam Project* was initiated by the State in 1867, and the work at Henry opened in 1871, and at Copperas Creek in 1877. The Federal project followed in 1880 with the work at La Grange, opened in 1889, and at Kampsville in 1893.

*The Solution of the Sanitary Problem* of Chicago, by the dilution method, was exhaustively investigated by the City and State authorities in 1885-9, and promoted to a conclusion in Legislation by the General Assembly in 1889. The water supply problem

thus provided for, the Waterway project reverted to the original conception but on a deep water basis.

*The Legislation of 1889*, and all legislation since, contemplates a broad project of conservation involving in one program, sanitary provision for Chicago and the valley cities, a deep waterway, harbor development at Chicago, water power, and reclamation of bottom lands. In furtherance of this program, provision was made for removal of the State dams at Henry and at Copperas Creek and the United States was asked to change its project to an open channel to be improved by dredging in conjunction with a water supply from Lake Michigan and to otherwise cooperate in a deep-water policy.

“*Fourteen Feet Through the Valley*” is the legislative intent, and represents the feasible depth by an increment of ten thousand (10,000) second-feet, the minimum capacity provided for the Main Channel of the Sanitary District, and also the river improvement required to avoid accentuation of overflows.

*The Conflicting Interests* of the Canal Commissioners and the Federal engineers prevented the removal of the dams at the opening of the Main Channel (January, 1900), as contemplated by State law, and deferred the open channel program, all as set forth at length in the accompanying brief. Whatever reasons to the contrary may have existed heretofore, the dams are now a nuisance to be abated at once. The increment of water in 1913 was seven thousand one hundred eighty-five (7,185) second-feet and the Sanitary District is prepared to increase the volume from time to time according to the legal requirement. The volume of water is now more than



adequate to the depths contemplated by the dam projects, and increases thereof, in the presence of the dams, will accentuate overflow and is the subject of protest in the valley.

**2.** *The Federal Report* of the Ernst Board (otherwise known as the "Fourteen-foot Board") was based on elaborate and exhaustive surveys, costing \$200,000, made in 1902-4. (H. R. 263, 59th Cong., 1st Sess.) It finds that (p. 18) "The additional flow provided by the Chicago Drainage Canal is now four thousand two hundred (4,200) second-feet. It will allow the removal of the present locks and dams, and will make practicable the maintenance of an open channel considerably deeper than the seven (7) feet now provided by these structures. The increase to ten thousand five hundred (10,500) second-feet makes practicable a still greater open channel." And (p. 11) "In a future not remote, larger volumes of water may be needed for sanitary purposes and channels deeper than fourteen (14) feet will then become practicable in the open alluvial section of the Illinois River."

*The Findings* are significant as they follow the established flow of water through the Drainage Canal, and justify the considerations underlying the legislation of 1889 and later additions thereto. They verify the feasibility of the fourteen (14) foot project and point out that greater depths may be had with increments exceeding ten thousand (10,000) second-feet. The Drainage Canal has an actual capacity of fourteen thousand (14,000) second-feet, and one thousand (1,000) to two thousand (2,000) second-feet additional may be had through the Illinois

and Michigan Canal. With such volume, the report of the Internal Improvement Commission of Illinois of 1907, finds that twenty-four (24) feet, the depth of the Drainage Canal, can be carried to Peoria and eighteen (18) to twenty (20) feet thence to the Mississippi.

*The Special Board* of U. S. Engineers, in its reports of 1911 and 1913 (H. R. 762, 63d Cong., 2d Sess.), favors depths of eight (8) and nine (9) feet and states that the same may be had with the aid of the present locks and dams and a volume of one thousand (1,000) second-feet; but the Reviewing Board recommends that this proposition be deferred until the diversion of water is finally determined: "Not only may this affect the attitude of the State toward the work (Upper Illinois) but also, when the approximate minimum flow is known, it may be found advisable to substitute open channel work for the four existing locks and dams that are retained in the plan of the Special Board."

*The Minimum Flow* of four thousand one hundred sixty-seven (4,167) second-feet is conceded by Federal permits and the pending case against the Sanitary District of Chicago seeks only to enjoin the diversion of waters in excess thereof. The recommendation of the Special Board has, therefore, no standing in fact and falls back on the recommendation of the Reviewing Board and the findings of the Ernst Board, which are to the effect that eight (8) or nine (9) feet may be had with such increment in an open channel and without the aid of the locks and dams. In view of the established minimum flow of 4,167 second-feet there are, therefore, no official ob-



jections to the removal of the dams but positive recommendations for open channel treatment.

**3. *Experience with Steady Flow*** in the upper half of the river, between Utica and Havana, indicates that an increment of four thousand one hundred and sixty-seven (4,167) second-feet (250,000 minute-feet), produces a stage of five and one-half ( $5\frac{1}{2}$ ) feet to six and one-quarter ( $6\frac{1}{4}$ ) feet above the natural low water of the open river, or seven (7) to eight (8) feet on the original bars. This represents nine (9) to ten (10) feet in the dredged channel projected by Wilson as the alternative to the lock and dam scheme.

The actual increment of five thousand (5,000) second-feet gave better than six (6) feet above natural low water throughout. The profile of 1903 shows filling approaching to or even above natural low water in localities, but there is warrant for the suggestion that such filling has been arrested by reason of the increased flow. Again, the river bed has been deepened in localities under the Federal appropriation of 1907. A re-sounding of the river bed is desirable. There is no question, however, but that the increment of 1913 was more than equivalent to the navigable depth of six (6) feet contemplated by the dams and that the maintenance of the volume required by the organic law will increase the same. There is also no question that very limited dredging of the fills on bars which have occurred since the dams were built will give seven (7) feet without the aid of such dams with an increment of four thousand one hundred sixty-seven (4,167) second-feet.

*Experience with Steady Flow* in the lower half

of the river between Havana and the mouth, indicates that an increment of four thousand one hundred sixty-seven (4,167) second-feet, or two hundred fifty thousand (250,000) minute-feet produces a depth of seven (7) feet with slight dredging between Pearl and Hardin in the channels, shown by the Lydecker profile in 1879, which represented the results of river improvement by dredging in an open channel, 1871-9. By the profile of 1902-3, some re-dredging will be required on bars which have filled since the lock and dam project was adopted in 1880; but these fills may have since been removed by pool dredging still in progress. An increment of five thousand (5,000) second-feet shows seven (7) feet throughout on the Lydecker profile. The increment of 1913, and the volumes to be maintained under the organic law are adequate to the removal of the dams under any condition. A re-sounding of the river-bed is also desirable.

*The Beneficial Effects* on the Mississippi River improvement are being utilized and the adopted low-water plane has been amended from a point twenty-five (25) miles above Grafton to St. Louis, such plane corresponding to one and five-tenths (1.5) feet above the old improvement plane at Grafton. This is significant in a project for six (6) feet of water and also by reason of the fact that the officer in charge of this district was a member of the Special Board whose report has been interpreted, in some quarters, as adverse to the open channel improvement by the aid of an increment of water from Lake Michigan.

4. *The Shrinkage of the River-bed*, and the raising of its bottom through the agency of the dams,



are not arguments against their immediate removal by reason of any local deficiency in bar depths which they may have occasioned. This will probably correct itself, or need but slight aid. This shrinkage in the period of thirty-six (36) years prior to 1903 diminished the bank-full capacity by fifteen (15) to twenty (20) per cent in the portion of the river dominated by the State works. The shrinkage in the river dominated by the Federal works had manifested itself, to a limited degree, prior to 1902-3, but the period under dams had been insufficient for tributary contributions to reach the main stream in large amounts. Local reports indicate, however, that extensive filling is now occurring. The Federal dams are relatively much higher than the State dams and in themselves appear to have diminished bank-full capacity by some twenty per cent (20%). This, together with shrinkage of river-bed, will produce an ultimate effect more serious than that due to the State dams.

*The Physical Conditions* determine the expediency of removing the dams, apart from any question of navigation. They are detrimental to reclamation and to the fisheries; they accentuate the claims for damage against the Sanitary District; they promote rapid decay of the river, and their retention is disastrous to sanitary projects and conditions and to other schemes of conservation.

*Navigation* will be prejudiced by the retention of the dams. Eight (8) or nine (9) feet, which measures the useful limits of depth in the minds of Federal engineers, can be had in an open channel with the conceded increment of four thousand one hundred

sixty-seven (4,167) second-feet and at no greater cost than estimated by the aid of the dams and a nominal water supply, and with practically no cost for maintenance and operation.

*An Actual Appropriation* of one million dollars (\$1,000,000) for the deep waterway was made by Congress in 1910, subject to an understanding with the State of Illinois. The Lakes-to-the-Gulf Deep Waterway Association, in 1912, sought to divert this appropriation to the dredging of the Lower Illinois in connection with the removal of the dams. The hearing in the matter developed the proposition that the State should act by removing its dams as a condition precedent to the removal of the Federal dams and the application of the appropriation as requested.

5. *The Deep Waterway* depends on increments of water in excess of four thousand one hundred sixty-seven (4,167) second-feet, or two hundred fifty thousand (250,000) minute-feet, which is adequate to an open channel depth of eight (8) feet and nine (9) feet as suggested by the Federal Boards. State policy, as developed in the organic law of the Sanitary District and collateral legislation, contemplated a feeding channel across the Chicago Divide, with a capacity of not less than ten thousand (10,000) second-feet, or six hundred thousand (600,000) minute-feet, and a navigable depth of fourteen (14) feet from Joliet to the Mississippi. The feeding channel was actually made of a capacity of fourteen thousand (14,000) second-feet, or eight hundred forty thousand (840,000) minute-feet. Summit level of the Illinois and Michigan Canal has an additional capacity



of more than one thousand (1,000) second-feet, or sixty thousand to one hundred thousand, (60,000 to 100,000) minute-feet operating to its full capacity in the manner prior to the opening of the Drainage Canal.

*The Internal Improvement Commission of Illinois* in its report of 1907, recommended the extension of the depth of the Main Channel, twenty-four (24) feet, to Lake Joliet, that all structures in the Upper Illinois be constructed for an ultimate depth of twenty-four (24) feet, that the intermediate pools and Lower Illinois be given a preliminary channel depth of fourteen (14) feet and that water power should be developed under public ownership. It found that the depth of twenty-four (24) feet could be carried to the City of Peoria and eighteen (18) to twenty (20) feet thence to St. Louis. Upon this report, the General Assembly submitted the constitutional amendment, which was voted in 1908, authorizing the expenditure of twenty million dollars (\$20,000,000) for the development of the waterway and incidental water power between Lockport and Utica.

*The Federal Report* of the Barlow Board, in 1900-1, determined the feasibility of producing a depth of fourteen (14) feet from Lockport to the Mississippi River. The elaborate report of the Ernst Board in 1905 submitted plans and estimates for such depth from Lockport to St. Louis, and is referred to above. The report of the Bixby Board in 1909 adopted the report of the Ernst Board and determined the practicability of extending fourteen (14) feet to the Gulf of Mexico, but this Board questioned the economic justification for a depth exceed-

ing nine (9) feet. It thus appears that adverse opinion respecting the deep waterway turns on advisability and not on practicability.

6. *The Congress*, in 1910, actually appropriated one million dollars (\$1,000,000) to begin the deep waterway, subject to the determination of a joint program between the United States and the State of Illinois. A Special Board was authorized, but it reported prematurely and adversely in January, 1911, and its findings were the subject of protest by the Governor and the report was practically withdrawn by the President in his message of December 21, 1911. The Governor did not recommend to the Assembly the appointment of conferees and no action was taken by the State, presumably for the reason that the case had been pre-judged. The Special Board made its final report recently and its findings respecting the Lower Illinois are referred to above. It finds, further, that the diversion of the large volume of water proposed can be compensated by contracting the lake outlets at a cost of four hundred seventy-five thousand dollars (\$475,000) with fifteen thousand dollars (\$15,000) annually for maintenance, or about the same as the cost of maintaining and operating the two Federal dams at La Grange and Kampsville. It finds also that flood stages in the Mississippi River will not be materially increased. It reports adversely on the two dams in the Mississippi River which were intended to make practicable the extension of depths greater than fourteen (14) feet to the Lower Mississippi River at Cairo. But this is immaterial at this time and will be considered later.



*A Large and Steady Volume* of water is demanded by sanitary purposes at Chicago and in the valley and by the physical conditions in the water course. Such large volume automatically makes deep water and it may be utilized on the largest scale by a federal expenditure less than was estimated in 1890 for the shallow waterway of eight (8) feet, constructed at the sole cost of the United States. On the other hand, deep water is not practicable without such large volume of water. Deep water to the Mississippi is, then, a necessity with or without the co-operation of the United States. Its advocates hold that it is justified without regard to the Mississippi River.

*The Lakes-to-the-Gulf Deep Waterway Association* stands for the entire project. The annual convention at St. Louis in 1910 declared in favor of a preliminary depth of fourteen (14) feet, with all structures based on an ultimate depth of twenty-four (24) feet, and this program was reiterated at the convention at Chicago in 1911 and at the Little Rock Convention in 1912.

**7.** *The Delay* in the Deep Waterway is due to a number of causes:

(a) When the constitutional amendment was submitted in 1907, the General Assembly directed the Governor and the Attorney-General to bring action for the ejectment of hydraulic parasites from the stream. The decision of the State Supreme Court in 1909 was, in part, adverse and the General Assembly in 1911 directed an appeal to the Supreme Court of the United States and the case has been submitted and is now under advisement.\*

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\*Held June 22, 1914, that State cannot raise Federal question.—(Ed.)

(b) Meantime, in 1909, a parallel case was brought directly in the United States Circuit Court and the same was submitted February, 1913, and is still under advisement by Judge Landis.

(c) In 1908 the United States filed a complaint against the diversion of waters from the Calumet River by way of the Sag Valley Canal. In 1913 a broader bill of complaint was filed against the diversion of any waters in excess of four thousand one hundred and sixty-seven (4,167) second-feet or two hundred and fifty thousand (250,000) minute-feet. The two cases have been joined, the testimony practically taken and printed, and the final hearing is on in the Circuit Court.

*The Former Governor* urged action from the passage of the Constitutional amendment to the end of his term in 1913, even to the point of conceding rights to water power claimants, but the General Assembly was indisposed to release the twenty million dollars (\$20,000,000) until the rights in the stream had been determined and until the water supply was assured beyond recall and until some program of co-operation with the United States had been agreed to which would not subvert and make abortive the policy of this state and the great expenditures made thereunder and the further expenditures predicated thereon.

*The Interregnum* has been utilized by shallow waterway advocates to deprecate the deep water movement and urge immediate results, but it is presumed that such advocates are ignorant of the fact that such limitation in depth blights and makes useless the investment for the sanitation of Chicago and the val-



ley; and further, that any limitation of water supply knocks out in effect the Constitutional Amendment under which the waterway investment is to be amortised by water power earnings.

In other words, we come back to the dictum that an adequate water supply means deep water, and deep water means an adequate water supply.

LYMAN E. COOLEY.

May 18, 1914.









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